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Controlling the Immaterial

THIS is criticized as a materialistic age.

Discovery and invention have furnished man with new materials and new uses for them, new means of communication and transportation, widely accessible and easily controllable power.

Tools and machinery have mitigated his commitment to hard labor for life. Ingenious instruments and newly discovered instrumentalities extend his perceptions and permit him to study Nature in her workings, from the electron in the atom to the stars in the universe.

We can make more things, make them better, in less time, each can have more of them and more leisure to enjoy them than ever before in the history of the race.

Rational study of the human organism and its afflictions is conquering disease and crushing out pestilence.

But in those things that appeal to the mental, the intellectual, the emotional side of man, we have not made commensurate progress.

We make grander and better organs and other musical instruments than our ancestors knew, but do we produce better music?

We reproduce through better mechanisms, but what do we produce? We develop Hope-Joneses and Steinways, but no Beethovens and Chopins.

Our stages are marvels of artistic, luminative and mechanical effects, but what do they put out that will go down through the ages and stimulate the thinking and the acts of man?

Three and a half centuries have not produced another Shakespeare.

"As a man thinketh so is he." The thing that makes a nation or a civilization is its state of mind.

When will the science of Psychology become a useful art? When will Philosophy, which is to wisdom what analysis is to knowledge, produce another master?

When shall we learn to manipulate and control the subtle processes of the mind, to cultivate social virtue and eradicate unsocial propensities in the same rational and effective way that we control the materials and the other forces of nature in the service of man?

F. R. Low

Training for Welding Must Start at the Top

WELDING, still relatively new to industry at large, has brought new problems of personnel and management. It is not so much a matter of finding mechanics who can be taught to make good welds, as of securing the proper ability and the right attitude in designers, supervisors and executives.

More and more the conviction is growing that training for effective welding must start at the top and work down. Nothing worth while can be accomplished where executives have antiquated notions about welding and no conception of the essential requirements.

Executives who understand the special requirements of welding organizations will know how to pick the right men for supervisors, and will give them the necessary support and encouragement. Such supervisors, thus backed, can pick the right men for operators, establish and maintain adequate machinery for training and qualifying welders and for supervising their work. If the organization is right at the top it will be right all down the line.

Propaganda and Education

INFLUENCED no doubt by the claim of Harriet Beecher Stowe that her story "Uncle Tom's Cabin" freed the Southern slaves, a thousand pens have been busy in portraying the wretched slavery under which the educators of the country exist. All this has been wasted effort. The tears have been unnecessary. The educators have discovered a way of escape from their economic bonds. They have learned what pay the movie star gets for proclaiming that there is not a cough in a wagon load or that she retains that complexion through the agency of some magic grease. The idea looks good—it is adopted but revamped to appear a little less vulgar. They are becoming pamphleteers and scriveners of sales arguments on public utilities.

That a college professor should spend some of his idle hours in writing for outside parties cannot be objected to. But any member of the teaching profession, a profession we assume to be open and fair-minded, who permits an essentially sales argument to be published under his signature as professor of this or of that, and which does not plainly show that he is the paid agent of an interested party, and through his standing as a teacher causes it to be introduced as a textbook into the public schools, is not being honest either with his fellow-teachers or with the public. For a few dollars he is bringing discredit upon the whole body of earnest hard-working high-minded educators.

The future of any country depends upon the thoroughness with which it trains and educates its youth who must carry on the work now started. It is paramount that only true and unbiased facts should be taught during the early schooling period. Propaganda of any kind has no place in our educational institutions of today.

The investigation by the Federal Trade Commission of the publicity and public-relations activities of the public utilities has so far shown that they have carried on a most thorough advertising and publicity campaign. For this alone there can be no censure. When, however, this campaign carries propaganda into the schools, as the Commission has shown to be the case in Connecticut and Illinois, it is time to call a halt.

In Connecticut the utilities have prepared a pamphlet that is used in many of the high-school classes in civics, which is intended to show the alleged failure of municipal utility enterprises. Similarly, in Illinois textbooks prepared and published at the expense of the utilities have been used in six hundred schools of the state.

If nothing more is accomplished than the finding and stopping of interference by the outside and interested parties in the nation's educational system, the investigation will have been well justified.

Remember the Operator

THE engineer who designs a power plant should bear in mind the man who is to run it day in and day out. Remember his physical and intellectual limitations.

For instance, nobody likes to run up and down stairs or ladders time after time every day. It is ridiculous to expect it. Things that need frequent attention should be easily accessible. And provision should be made to keep work places cool in summer and warm in winter and well ventilated all the year. Make the plant pleasant and easy to operate.

On the intellectual side find out what sort of man is to be employed in the plant. Do not ask a low-grade man to be a wizard at understanding a complex layout or keeping track of the indications of a dozen instruments that indicate obscure things and drawing appropriate conclusions. He can't.

If men of higher intelligence and experience are to be employed, on the other hand, don't waste money doing their work for them. Automatic controls, for example, are designed to eliminate thought and attention. If these are to be available, automatic devices lose some of their usefulness. At the other extreme, automatics will be ill-placed in a plant that is wholly unprovided with expert attendance. They need somebody to keep them going aright.

And so it goes. Examples might be multiplied, but the truth is evident to every power engineer of experience. A plant that is designed with an intelligent consideration of its operating personnel is a delight. One that is not may be a nightmare, quite literally.

Two Hundred per Cent on the Investment

WHEN securities are bought, the yield is generally a measure of the risk. Twenty per cent is not obtainable on gilt-edged bonds. Yet far higher percentages can often be made without risk in the industrial plant.

Take heat insulation, for example: It is a fact that one foot of bare three-inch steam pipe will waste about half a ton of coal per year. A good grade of pipe covering will save about 90 per cent of this fuel, so that at current prices, the job pays for itself in less than six months. Here is 200 per cent on the investment—and a sure thing at that.

Why in the world, then, are steam pipes ever left bare? Perhaps the answer is too much fancy mathematics. Some may have the idea that the ordering of pipe covering should always be preceded by a long session with pencil and pad wherein one laboriously computes surface areas, heat radiated per square foot for various curvatures, percentages saved by pipe covering of various composition and thickness, and so on all day.

But why hold up the works until one can find time for such a computation? It will merely prove what everybody knows anyway—namely, that the pipes ought to be covered. And it will prove also that the heat lost by the bare pipes while the computation was being made would run the family flivver from New York to San Francisco (or choose your own cities).

This brings to mind an amusing incident. An engineer dickered for four weeks with various makers of pipe covering to get the lowest price on an eighty-five per cent magnesia job. He finally succeeded in knocking off five per cent from the first bid submitted and patted himself on the back for his "shrewdness." He never knew that the fuel wasted during the extra month of bidding cost him at least fifteen per cent of the price of the covering.

This is not to be construed as a criticism of the careful planning for new installations. It does mean that where bare piping exists in an operating plant, the thing to do is to order some good covering in a hurry and forget about the scientific refinements.

When the barrel is leaking at the bunghole one doesn't scour the country for lowest price on corks.

What Is "Yankee Ingenuity"?

WORCESTER Polytechnic Institute is faced with a problem that is unusual, to say the least. Henry J. Fuller, a graduate, has endowed a scholarship to be given to the entering freshman who has exhibited the greatest amount of "Yankee ingenuity."

Now the question arises as to just what this quality is. In an attempt to decide, the institute requested some fifty prominent engineers and business men to submit definitions. Returns have been of great interest, but resulted in no exact determination of the basis of award. So a committee has been intrusted with the duty of picking the lucky candidate.

We do not pretend to be able to define this famous New England trait. But we are sure that the freshman with enough "git-up and git" to win the scholarship will need to have "Yankee ingenuity" sufficient to satisfy the donor.

Group Drive in Power Applications

THERE is a general idea that the old question of group versus individual electric drive has long since been settled in favor of the latter, except where small, constantly operating machines may run in groups. An inquiry among plant engineers will show that the reputed advantages of individual drive are not so generally accepted as might be indicated by some of the developments in industry. There are plant engineers who favor group drive for many applications and have proved to their satisfaction that such drives, when properly installed and maintained, are superior to the individual motor on each machine. Opposed to these are engineers who have been equally successful with individual drives in the same applications. Therefore this question which has existed almost as long as the electric motor, is not nearly so definitely settled as some are inclined to believe.

In the question of group versus individual drive there are many intangibles, the value of which no two engineers will agree upon. One engineer may dislike the appearance of a plant that is all cluttered up with belting, shafting and gearing, where another would not object to these conditions. Safety, cleanliness and lighting are other features that might be given different weights by different engineers.

Even in those factors of a more tangible nature the experience of different engineers may vary widely. Take lineshaft losses, for example. These may vary one thousand per cent, depending upon the arrangement, the type of bearing, lubrication, shaft alignment and belt tension. If a very poor lineshaft installation were replaced by individual motor drives, the results obtained would probably be gratifying. Change from a high-grade group drive, properly maintained, to individual drive might be a disappointment as far as power savings and increased production are concerned. Changing from group to individual motor drive has in some plants cut the power consumption in half, but such results cannot be taken as the saving under every set of conditions.

There are certain applications in which it is definitely established that individual drive is the best. There are others where group drive is admitted to be superior. Between these two are many conditions under which the best solution is open to question and which require individual consideration. An analysis of these conditions will show that group drive has a more extensive field than is generally allowed, and instead of being a thing of the past, it still occupies an important place in power application.

Heat Interchangers

THERE are some industrial plants where the water available for boiler feed is bad, owing to the presence of soluble salts of the alkali group and to scale-forming solids. When large quantities of steam are needed for industrial purposes, the problem of efficient operation of boilers with such feed water becomes troublesome. Blowdown must be frequent and copious. Scaled boilers need cleaning, and the presence of scale reduces heat transfer when in operation. Finally, the cost of treating the feed water, when such treatment is supplied, is often relatively large. Evaporators have often not been considered warranted on account of the large amount of makeup required.

It is well known that boilers can be operated both at higher ratings and at higher efficiency if supplied with pure feed water. These gains will offset to a considerable extent the costs of equipment to insure distilled water. A number of European plants have installed heat interchangers, or what may be called reboilers, for this purpose. These are virtually large size, high-pressure, single-stage evaporators. Steam at boiler pressure is furnished to the reboiler to evaporate raw water, which furnishes steam to the industrial demands. Closed types of reboilers are used, so that the two fluids do not mix. The high-pressure condensate is pure and can be returned directly to the boilers as feed water. No contamination from leakage can occur as in high-vacuum surface condensers, as the pressure differential will prevent raw water from leaking into the high-pressure steam space. The moderate steam temperatures are said to produce only soft mud in the raw-water tubes rather than hard scale; hence, the reboilers are easy to clean.

In view of the success reported with such equipment abroad, is it not possible that American industrial plants may find that large savings can be secured by the use of such heat interchangers?

Eli Lilly & Company make a highly diversified line of products

Power Services in the Manufacture of Pharmaceuticals

By Graham L. Montgomery
Editorial Staff, Power

IN APPLYING power services in any industrial plant, it is always necessary to select the system that results in the lowest cost for finished goods. The ideal condition exists when all the process steam used is exhaust or bled steam and all the electrical, air, hydraulic and other services can be generated by the reduction of this steam from boiler pressure to process pressure. In such a case there is no necessity for purchasing current or for generating it in condensing units. The heat produced in the boilers, in the form of steam, is all utilized, except for unavoidable radiation losses and losses inherent in the design of the production equipment. Power services are, therefore, produced at the minimum cost and utilized with the best obtainable economy.

But a plant where conditions of this nature exist is rarely, if ever, found. Most places have excess requirements for either power or heat that make it impossible to obtain such a balanced condition. And in many cases the winter necessities are vastly different from the summer demands, making any system a compromise.

In making a choice of power equipment and operating methods it is, therefore, necessary to make a thorough study of the industrial plant in which the power services are to be supplied, both as to the production equipment and the manufacturing processes used. The final choice will depend upon the results of this investigation. But in reaching a decision one goal must be kept in mind—that the cost of these power services, as represented in the cost of the finished products of the plant, should always be the lowest that can be obtained.

An interesting solution of this problem has been made by Eli Lilly & Company, Indianapolis, Ind. In this plant the requirements for exhaust steam for all purposes, being partly supplied by the exhaust from air compressors, auxiliaries and other steam-driven equipment, do not permit the generation of all the electricity needed unless part of it is generated in condensing units. This has been taken into consideration in arriving at the method of power service supply used by this company, with the result that a heat balance that is nearly perfect, considering only the amount of heat in the steam produced, is attained.

The Lilly plant, aside from its power problems, is one of the outstanding organizations of this country. Here are manufactured an extremely large and varied line of pharmaceutical and biological products, the factory being one of the largest producers of this line of goods in the world. Of this output over 2,800 different items are made under one roof, in a single five-story building, by straight-line production methods, using a single system of conveyors. Such a system is difficult enough to devise when applied to a single product, as for instance, a Ford car. When used for the production of so many different items, the application becomes much more complicated.

However, highly successful results have been obtained, accompanied by reduced labor requirements and the speeding up of production. Through the use of the most detailed scientific analysis of the processes employed, by both the engineering and production departments of the plant, results have been obtained which are remarkable, particularly in view of the rigid chemical and sanitary control under which goods of this nature must be turned out, in order to insure accuracy of formula and purity of content. It has been necessary to develop wholly new machines and methods to accomplish this.

Straight-line methods are applied to the manufacture of biologicals (serums, glandular extracts and vaccines) and to all other products made by the company; but the

single conveyor system referred to in this article is used for the manufacture of pharmaceuticals, consisting of powders, capsules, pills, tablets, ointments, extracts, emulsions and elixirs. In the five-story building in which these goods are made, the raw materials are assembled on the upper floors and processing and packaging are carried out as the materials progress toward the first floor. Other products are made in the same general way, but the complication is much less.

Power services required for operation of the pharmaceutical division of this company (and also for that part of the biological work that is carried out at the Indianapolis works) consist of electric power; steam for processing, for building heating, and for air conditioning; refrigeration for process work and air conditioning; compressed air; and water service, both raw and distilled water being used. Alternating current, 440-volt, three-phase, is purchased at the rate of 180,000 kw.-hr. per month. Direct current, 110-volt, is generated at the plant at the rate of 60,000 kw. per month.

The steam generating equipment consists of five water-tube boilers. Two of these are Type E Stirling boilers of 2,000 sq.ft. of heating surface each. The other three are two Type L and one type E Stirling boilers of 3,000 sq.ft. of heating surface each. Two of the boilers were installed 27 years ago and the others in 1904, 1913 and 1927. The older boilers have been kept in good condition, and all are operated at 175 per cent of rating and evaporate from 10 to 15 million pounds of water per month.

Green chain-grate stokers are used. The fuel is Indiana screenings of an average of 11,000 B.t.u. per lb. heat content. The boilers are equipped with Vulcan soot blowers, Copes feed-water regulators, and Hagan control for dampers and stoker speeds. Draft is obtained from a stack 6 ft. in diameter and 163 ft. high. The feed water is treated in a Cochrane-Sorge softener, and a compound is used in the boilers. The boiler plant runs at capacity during the day, but at night is operated only to take care of building heating and other smaller loads.

Direct current is generated by two simple Corliss engines, exhausting at a back pressure. One of these engines is a 16x36-in. Atlas, generating 100 kw. at 100 r.p.m. The other engine, a Hoovens, Owens, Rentschler, generates 150 kw. at 100 r.p.m. and is 18x42-inch.

Air is compressed in one 1,600-cu.ft. Worthington compressor and one 1,000-cu.ft. Ingersoll-Rand compressor. These machines are steam-engine-driven and exhaust at a back pressure high enough to supply steam to a 10-lb. process main.

Refrigeration is supplied by both absorption and compression systems. There are two Vogt absorption systems, one of 75-ton and the other of 60-ton capacity. A number of small compression refrigeration units are used located at the point of application. The smallest of these are Frigidaires. The other units are: One 30-ton Baker machine; two 25-ton York machines, one 20-ton Brunswick machine; one 10-ton Frick machine; three 8-ton and one 2½-ton Automatic machines.

Two sources of water are utilized—city water supplied under pressure from the local water company and well water raised by air-lifts. These supplies are interconnected but, generally, city water is used for sprinklers and other fire-protection service and for boiler-feed makeup, while well water is used for condensers and other cooling equipment. For process work, both city and distilled water are used, as fits the case.

The wells are served by tanks equipped with floats controlling the air lifts, so that a constant level is maintained in them. Certain water-using equipment is supplied by centrifugal pumps directly from these tanks, as, for example, the condensing coils of the refrigeration equipment. For other water uses there is a 12,000-gal. roof tank, filled by centrifugal pumps from certain of the tanks served by the well air-lifts. This high tank is also equipped with a level control, which acts on the centrifugal pumps and thus maintains a constant level. In addition, there is a 50,000-gal. elevated sprinkler tank, filled from the city water system, but with a cross connection to the wells.

An interesting feature of this water system is the fountain shown in Fig. 6. A court between two of the buildings, formerly a roofed-over manufacturing space, was cleared out and a concrete fountain built. This is connected to one of the air lifts, the overflow being piped under the pavement to one of the tanks. In summer this courtyard is furnished with growing plants and flowers, making a beauty spot within the factory

Steam is used at three pressures—130 lb. gage, 10 lb. gage, and 1 lb. gage. This is all saturated steam. The applications have been carefully made so that 130-lb. steam is only used for heating processes requiring temperatures over 225 deg. F and for prime movers. The 10-lb. steam is largely exhaust from the air compressors. At times, when this exhaust is insufficient, 130-lb. steam, reduced in pressure by passing through a reducing valve,

Fig. 1—View of main plant of Eli Lilly & Company, Indianapolis, Ind.

is used to supply the lack. The 1-lb. steam is the exhaust from the remaining prime movers and auxiliaries, plus steam from the 130-lb. or 10-lb. mains, reduced to the required pressure.

Building heating is carried out with the 1-lb. steam. In summer, when this load is missing, there is an increased demand for the dehumidification of air for process work, which necessitates full use of the absorption refrigeration system, thus making a use for a large part of this low-pressure steam. Since any excess of steam of the other pressures is reduced in pressure to one pound and fed into the low-pressure system, the only waste that can occur is at that pressure.

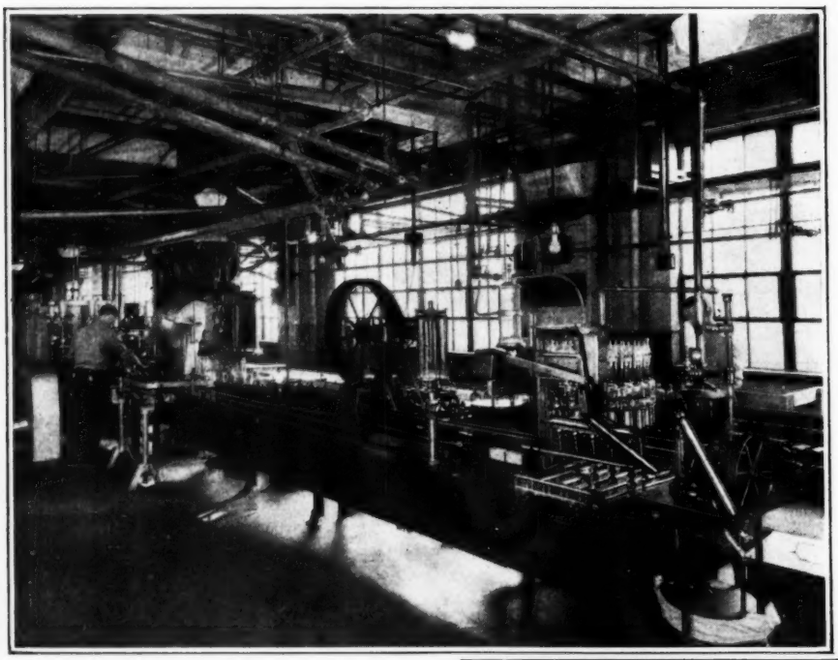


Fig. 2—Bottle-filling machine
Note individual drive at right, with motor belted to machine.

However, the steam production and demand are so well balanced that waste occurs only when, for some reason, part of the production equipment is taken out of service temporarily. Ordinarily, manufacturing to stock, as this plant does, the load for a given period is sufficiently steady so that no heat waste occurs. This could not be so except for the care that is taken to insure that all process work is carried on with the lowest possible of the three available steam pressures. For instance, the rectification of alcohol that has been used in extraction processes is carried out in column stills. Low-pressure (1-lb.) steam is used for this work, except for the final stage, when 10-lb. steam is applied.

All the steam used for various purposes is measured, Republic flowmeters being used for this purpose. These meters measure the total steam make; the steam used for power generation, air compression and auxiliaries; the live steam used for process work; and the exhaust steam produced. These records, together with the boiler-room records and the production department's figures, permit a complete check to be kept on the departmental and over-all economy of heat use.

Process uses of steam include process heating by each of the available steam pressures, depending upon the temperature needed in the process; atmospheric evaporation, drying and distillation by 10-lb. steam where temperatures above 212 deg. F. are required; and for all other work, the 1-lb. steam, including vacuum evaporation, drying, process heating, distillation and the making of distilled water.

Steam is produced in quantities varying from 10 to 15 million pounds a month. Electric generation requires 2,000,000 lb. a month. Air compression uses from 2,000,000 to 3,000,000 lb. a month. The remainder of the high-pressure steam is used directly in process work.

Refrigeration is used for the dehumidifying process mentioned previously and for cooling goods in process and storage.

Compressed air is used for the air-lifts, for cleaning, for displacement pumping of alcohol and other liquids and for a pneumatic tube system.

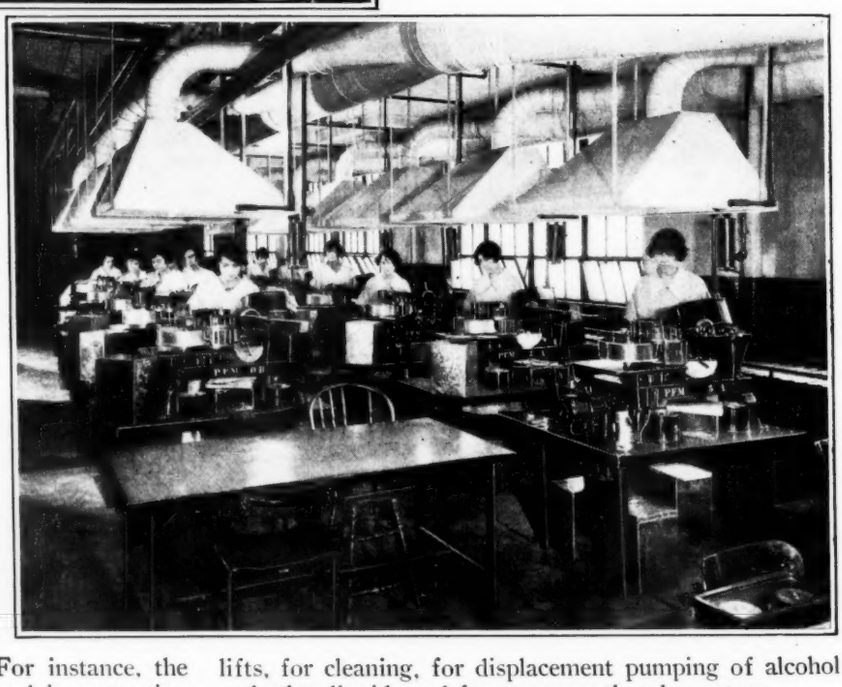


Fig. 3 — Capsule filling machines with individual, totally inclosed motors connected through gear reductions
Note the ventilating hood over each machine and its connection to the lighting system.

Electric current is used for motors and lighting. Under former conditions, when the output of the engines sufficed for the electric requirements of the plant, the motor equipment was all direct-current. Now, since the new conveyorized methods have been adopted, there are 150 alternating-current motors operating on purchased current on the conveyors alone; and many others on the production machinery throughout the plant. In all, there are over 1,000 motors in the plant, both alternating and

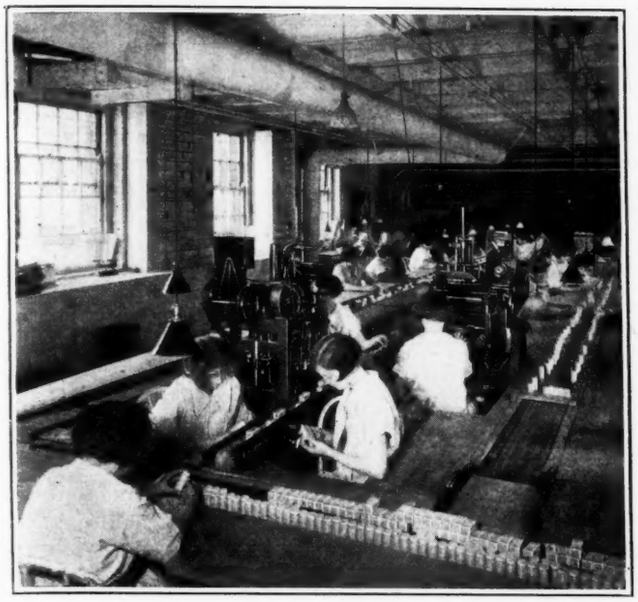


Fig. 4—Packaging machines with individual motor drives using both gear and belt reductions

direct-current. A 5000-kw. motor-generator set is installed as a stand-by, to provide direct current in case of an emergency.

Control of Power Services

The manufacturing operations and equipment of Eli Lilly & Company come under six department heads, reporting directly to the executive of the company. These departments are: Pharmaceutical manufacture; biological manufacture; research; storage and shipment of finished goods; personnel, statistical and accounting; and engineering. The engineering department, which is in charge of the chief engineer, has as its primary duty the supplying of all necessary power services for the plant's operation. Its next most important activity is the design, selection and manufacture or purchase of production equipment, which is often specially worked out for the needs of the plant, there being no stock designs of equipment available. All maintenance work is a function of this department, as are also all repairs. Construction of any new buildings for the parent company or its subsidiaries and branches, whether in Indianapolis or elsewhere, is also supervised by the engineering department. Other activities included the conveyors and elevators, fire prevention, watchmen, safety, private telephone, time and messenger (pneumatic tube) systems, supply of gas and the manufacture of capsules, which is carried out by the engineering department because it designed the equipment and because the activity is somewhat apart from the operations of the two production departments.

Fig. 5 shows the actual subdivision of the engineering department by means of which the chief engineer carries out his numerous and varied activities. One of the most important results of this method of organization is that the engineering department is in the closest possible contact with the production departments. Consequently, the requirements, as to quantity and quality, of the various power services are thoroughly known, and all the engineering department needs to do in addition, in order to supply the power services for any rate of production, is to obtain from the production department information as to what the production rate is to be.

In conclusion, there are three features of the power service supply system in force at Eli Lilly & Company that are suggestive to others who may be encountering difficulties in supplying these services economically. In a case where the steam requirements do not permit the generation of all the electricity needed by means of non-condensing equipment, central-station current was chosen to make up the deficit rather than condensing prime movers; and a saving was thus realized. Old equipment, some as much as 27 years old, is still used with economy, this equipment having been maintained so well that it is still more profitable to keep it in operation than to incur additional capital charges by buying new. And finally, the organization of the chief engineer's department has been made broad enough to include duties in all of the plant's activities, thus insuring that the power services will be intelligently supplied, keyed to the needs of the plant.

Fig. 6—Fountain in plant courtyard made from the discharge of air-lift from one of the plant service wells

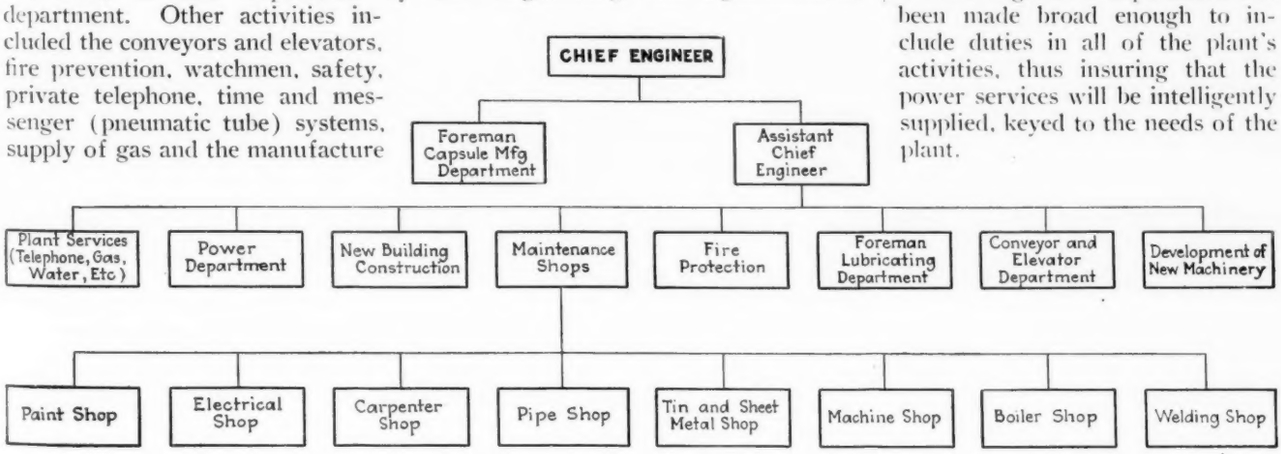


Fig. 5—Organization chart of the chief engineer's department of Eli Lilly & Company

Choosing Generating Equipment for Process Steam

By Theodore Maynz

Consulting Engineer, Cleveland, Ohio

THE boiler plant at the Cleveland works of the Canfield Oil Company consisted of four low-set horizontal return tubular boilers of 1,250 sq.ft. heating surface each, all hand-fired and in common battery setting; and three similar boilers (one of 1,500 sq.ft. heating surface fired by a Vee-type overfeed stoker) in another location. These last three boilers were formerly owned and operated by an ice plant and were about 200 ft. north and 500 ft. east of the other boiler house, across the main line and siding of the W. & L. E. R.R. The outgoing lines for steam consisted of one 6-in. from the ice-plant boilers and a 4-in., a 3-in. and two 2-in. lines from the refinery plant. All steam was generated at 90 lb. gage pressure and Lake Erie (Cleveland city) water was used as boiler feed. This water contains about 110 p.p.m. total hardness, with about 80 p.p.m. as calcium and 30 p.p.m. as magnesium hardness. There were no returns, and the boiler feed was 100 per cent raw water.

THE Canfield Oil Company, refiner of Pennsylvania petroleum, has refineries at Cleveland, Ohio and at Coraopolis, Pa. The steam generating equipment at Cleveland, two years ago, was in such a condition that a new plant was required at once. This article details the engineering considerations upon which choice of the new plant was based. A later article will describe the plant construction in full detail.

Steam is required in this refinery for five major uses. High-pressure steam is used in the crude stills for assisting the distillation process by lowering the temperatures. Steam is used for pumping crudes and finished products, and nearly all the pumps are steam-driven duplex. Steam is used for tank heating, and a continuous supply is required, as some tanks are heated all the year. As much exhaust steam as is available from the pumps is used for tank heating, but owing to the relative location of the pumps and tanks and to the quantity of exhaust, a large amount of live steam is required. Steam is used for the absorption refrigeration machine in the wax plant, where lubricating oils are made. High-pressure steam is used for steaming out and cleaning tank cars.

The first requirement was to determine the amount of steam to be supplied under both present and probable future conditions. As no records were available, this had to be determined by an analysis of the manufacturing process. This analysis showed that the load was fairly steady through the day, dropped off about 15 per cent during the night, and of course varied with the season and weather. This seasonal load variation was greater than the manufacturing load variation, and most important, as no stoppage of the supply of steam could be allowed during cold weather on account of freezing of the exposed pipe lines. The load analysis showed that about 10,000 lb. of steam per hour was the minimum and 30,000 lb. the maximum continuous demand, with half to one-hour peaks 15 per cent greater. Thus the load ranged from 24,000 to 30,000 lb. from November to April, from 15,000 to 24,000 lb. from April to June and September to November, and from 10,000 to 15,000 lb. for the three summer months.

To keep the investment cost low and the idle, or stand-by boilers at a minimum, it was decided that the equipment should be composed of two boiler units, each capable of carrying the entire load if required. The operating schedule called for two boilers steaming continuously throughout the winter months and one boiler in the summer, late spring and early fall. Should it be necessary to take one boiler off the line during the winter, the other would have to be able to carry the entire load alone. Had three smaller boilers been installed, two-thirds of the plant equipment would have been idle for almost half the year, and one-third idle almost the entire year, besides the higher first cost of the same output capacity in smaller units. As the probable electrification of certain existing and most of the future pumps was contemplated, and as no additional tank installation requiring heating was probable, and the new stills would require less steam for their operation than the present ones, no additional capacity was installed beyond their immediate need. Space and design, however, allow for the installation of another boiler, when required.

Choosing a Site

The site of the new plant was of prime importance. Naturally the best place, exclusive of other conditions, would be at the center of the load. This would be easy to arrange, except for one important consideration, the fire hazard. As this was of vital importance, the site chosen was at the location of the old boilers in the former ice plant, near the center of load, on a railroad siding,

and far enough away and very much higher than the refinery, so that the fire hazard was reduced to a minimum. The only objection was the necessity of constructing a new steam line from the plant running under the railroad tracks to the refinery, a distance of about 250 feet.

As all power plants resolve themselves into two types of engineering, one the thermodynamic and the other the materials-handling problems, this latter problem was attacked next. The receipt of coal was easily arranged, owing to the siding, but as no large ground space was available for storage, a silo was chosen as giving the largest storage per square foot of ground space. As all the ashes could be used for filling around the refinery, it was decided to build hoppers directly underneath the boilers. The ashes were to be dumped directly into metal-lined wagons drawn by small Fordson tractors. These wagons were being used around the plant and were already available. They hold about two yards each, and have large-diameter wheels, so that they can be used all over the refinery.

Water was easily obtainable from the city water mains by installing about 100 ft. of new water pipe from the street meter connection.

Selecting the Boilers

As most of the steam required was of relatively low pressure, 150 lb. gage was more than ample, and this was the pressure that was chosen. Since some superheat was desirable, both for stills and to prevent line condensation (and therefore wet steam to the pumps), superheaters were installed. This was limited to 100 deg. F., so that the maximum steam temperature would not exceed 475 deg., allowing the use of cast-iron fittings and valves, obviating the necessity of steel fittings which cost about three times as much as cast iron.

Owing to the use of raw water without any condensate returns, vertical, bent-tube boilers were chosen. Under these conditions, even when water treatment is used, boiler cleaning is more or less frequent, and the time required for cleaning the horizontal, straight-tube type of boiler makes it less desirable than the bent-tube type.

The coals available in this location are Ohio, West Virginia, and Eastern Kentucky. Although the two latter are far preferable, because of their high heat value and the high fusing point of the ash, the freight-rate differential and availability of supply under adverse conditions made it advisable to design the equipment for Ohio coal. This runs as low as 12,000 B.t.u. as fired, 15 per cent ash, 3-4 per cent sulphur, and 1,900 deg. fusing point of ash.

Four types of firing equipment were considered: Unit pulverizers, multiple-retort stokers, industrial type of underfeed stokers (single, double, or lateral retort), and forced-draft traveling grate. The last type of stoker is considered peculiarly adapted to this type of coal. However, after a careful analysis of the merits, costs and operating efficiencies of the various types under the extremes of rating required (from below 90 to over 250 per cent), multiple-retort underfeed stokers were used. A further consideration for the use of this type of stoker was that it allowed a considerable reduction in building space, valued at $9 per sq.ft. The chief consideration against the use of unit pulverizers was that the net increased efficiency under the operating conditions (after deducting the power required for pulverizing) did not show an adequate return on the increased investment. This high cost was primarily due to the advisability of water cooling a portion of the furnace, necessitated by the high rating.

The requirement of operating under high rating conditions for comparatively long periods, necessitated the use of a high stack. Steel stacks were ruled out at the beginning, owing to their high maintenance and the lack of space for proper guying. The minimum-size masonry stack that would give the required draft at the boiler breeching to obtain 275 per cent of rating, was 225 ft. The cost and complications entailed, both in design and operation, by the use of a combination of natural and induced draft, led to the conclusion that induced draft was desirable under all conditions. As the steam used by the fan drive could be absorbed in the feed water, the cost of power required for the operation of the induced-draft fans was negligible. The design of Prat-Daniels streamline stacks lent itself particularly well to the general layout, and therefore these were chosen and incorporated in the plant. Extending the cross-beams of the boiler steelwork to frame into the rear building columns, made a cheap and convenient platform to support the stacks and drive, and from this is also hung the breeching and the dampered cross-connecting emergency flue. This cross-connection flue allows the operation of a boiler with either stack. The saving in first cost for stacks, fans, drive and piping was estimated at $5,000 against a 225-ft. masonry stack and foundations.

Owing to the cost of power, which is all purchased, and the fact that all-raw water is used for boiler feed, steam drive was used for all the auxiliaries. To eliminate oil in the feed water, turbines were used wherever possible. The main feed pump, the forced-draft and induced-draft fans are turbine driven, and even the stokers are equipped with a built-in turbine drive. However, provision has been made so that both the stokers and the induced-draft fans can be equipped with motors, and a motor-driven forced-draft fan can be connected to the forced-draft flue.

To eliminate oxygen corrosion, a deaërating feed-water heater was installed, set 14 ft. above the boiler feed pumps, so as to eliminate any chance of steam binding, at high feed-water temperatures. After it was decided to use induced draft, the advisability of economizers or air preheaters was considered. A detailed analysis for a five-year period indicated that the added cost, maintenance and complications did not show a sufficiently

Is Economy Important in Process Steam Generation?

It certainly is and, at the Canfield plant it was the deciding factor in the choice of these features: Coal silo 150-lb. steam pressure. 100 deg. superheat. Vertical bent-tube boilers. Ohio coal. Multiple-retort underfeed stokers. Stream-line stacks. Deaerating feed water heater. Feed water deconcentrator. All-welded piping.

adequate return on the additional investment to make either proposition attractive. It was easy to incorporate ample provision for the future installation of either device, should changed conditions warrant.

The feed water used required that it should be treated to insure continuity of operation, so that the Hall-Hagan system of water analysis and the use of soda ash in conjunction with Hagan deconcentrators to reduce blowdown was selected. An assistant in the refinery laboratory easily takes care of the determinations for treatment.

How the Plant Is Operated

The plant is designed to be operated by one man and a helper, who unloads the coal, lubricates the machinery and keeps the plant clean. All repairs are made by the refinery mechanics, except that the washing and turbining of the boilers is done by the regular helper, assisted when necessary by a laborer from the refinery. Each helper is being trained as a plant operator, being a licensed fireman, and used as the extra operator on Sundays.

Automatic regulation is used to control the speed of the induced- and forced-draft fans as the load varies, and to maintain the draft in the furnace. The stoker operation is not controlled by the regulator, but by the operator, who is charged with the proper maintenance of the fuel bed. To guide him, each boiler is equipped with the necessary instruments.

The piping is nearly all of welded construction. An interesting fact is that the cost of all the piping except the trap, deconcentrator and meter piping, but including the soot-blower piping, completely erected was less with welded construction than the cost of materials alone when fitted piping was used. This type of construction also was used in the installation of the main header to the refinery and the new 8-in. steam main in the refinery, both of which contain no fittings whatever. All the piping was subjected to a cold-water test of 350 lb.; and, although some of the welded joints showed some slight leaks, these were very quickly made tight. When steam was turned on, not one leak was found at a weld, but quite a few troublesome ones showed up in screwed joints that had proved tight under the cold-water test.

The success of this welded construction is such that the writer will endeavor to use it on lines of ¾- and 1-in., and eliminate as many screwed joints and fittings as possible. All high-pressure steam flanges, 3-in. and over, were Van Stoned with low hub rolled steel flanges. Except for unions at the element heads all the soot-blower piping consists of long-radius bends welded to the main soot-blower pipe, eliminating all other joints. This piping, owing to the continual change in temperature, is especially liable to leak at the joints, and the use of bends and welding has made it troubleproof.

The coal-handling equipment incorporates, besides the silo, an electrically operated full-automatic skip hoist, capable of unloading and elevating about 30 tons an hour, and a 1,500-lb. traveling weigh-larry to feed the stoker extension hoppers. Coal is reclaimed from the lower part of the silo by a chute feeding back into the track hopper and from it to the loader for the skip hoist. The skip hoist was preferred as the most adequate elevator for high lifts.

Type of Building Used

As the writer, when operating power plants, never found a boiler room that was sufficiently light, he decided to have as much glass as was possible. Therefore both the front and rear walls are composed entirely of steel sash, without any brick pilasters, from 4½ ft. above the firing floor to the eaves, a height of almost 32 ft. The building is of steel construction, 49.5x41 ft. center to center of columns, 50 ft. from the ground to the bottom chord of the roof truss, with the firing floor 14 ft. above the ground. It is divided into three bays of 16.5 ft. each, each bay being occupied by a boiler and the first bay being utilized for the heater, stairs, feed pumps and office. The roof is of interlocking concrete tile. Brick is used from the ground to 4½ ft. above the firing floor on three sides, the east end being made of plaster on Hi-Rib lath for its entire elevation. This is the wall that will be removed when an additional boiler is required. The west wall is of plaster construction from 4½ ft. above the firing floor to the roof eaves. There are no windows in this wall, owing to the requirements of the building code in regard to the property line. The building was designed around the equipment by the Roberts-Wright Co., structural engineers, to incorporate the ideas of the writer for getting the cheapest building that would be permanent. No beauty of architecture was required in its location, so that it was designed strictly for utilitarian purposes. Its cost erected, including concrete for the boiler columns, platforms, stairs, but exclusive of plumbing and electric wiring and machine foundations, was 18c. per cubic foot.

The plant was designed to obtain an average yearly efficiency of 70 per cent or better with Ohio coals, and although no coal analyses are made, the average evaporation indicates that this efficiency is being realized. When first operated, certain serious troubles developed, but by the rebaffling of the boilers and the incorporation of a water spray to prevent clinker adhesion and the erosion of the bridge wall, the plant was put into operating condition. These changes required one boiler to carry the entire load almost all winter, so that the expected continuous high ratings were obtained. A detailed technical description with unit costs will be published in *Power*, May 29, 1928.

WHAT DO YOU KNOW?

By L. H. Morrison

The answers are on page 903

Ques. 1—What is heat?

Ques. 2—Who first established an engine's rating in terms of horsepower?

Ques. 3—Does the "fatness" of a spark have any influence on the power developed by a gas engine?

Ques. 4—What is the difference between the Stumpf uniflow and the Todd uniflow, the latter having been invented in England about 1870?

Ques. 5—Assuming a kilowatt-hour is equivalent to 3,415 B.t.u., which requires more energy to produce a ton of refrigeration, the compression or the absorption system?

Ques. 6—If you were "laying up" a furnace wall, how thick would you make the fireclay joints?

Ques. 7—What was the first air preheater to be in general use?

Ques. 8—Who built the first two-stroke-cycle gas engine?

Ques. 9—Who is Dean of Engineering of Princeton University?

Ques. 10—How does engineering rate among the professions as to remuneration?

Experiences with

BOILER GAGE GLASSES

By BEN G. ELLIOTT

Professor of Mechanical Engineering,
University of Wisconsin

THE short life of boiler gage glasses in many high-pressure steam plants is one of those exasperating things that bother operating engineers. The result of a survey by *Power* of the operating practices of a number of prominent plants is given in this article.

MANY interesting facts regarding the various troubles with water gage glasses in high-pressure steam service are revealed in a recent survey conducted by *Power* and covering the experiences of a number of important plants in various parts of the United States. The information collected pertains to such matters as the average life of gage glasses, nature of and reasons for failures, troubles with gaskets, and methods that have been used to prevent glasses from thinning out and from becoming opaque.

Practically all plants operating at 300 lb. and under use glasses of the tubular type. For pressure above 400 lb., however, the flat-type glass is generally used, although a few plants still use the tubular glasses for the higher pressures.

On first inspection little definite information seemed to have been obtained on the average life of glasses. The figures given showed that in some plants the average life of gage glasses is only about eight days, while in others it is from seven to eight months. A further study of the data submitted indicated that there existed a relation between gage glass life and steam pressure, and the curve in Fig. 1 was plotted to show this relation. This curve shows that for pressures between 200 and 400 lb. the gage glass life decreases rapidly with increasing pressures. Below 200 lb. the average life is independent of pressure and depends upon local conditions. It would seem that 400 lb. is close to the limit at which it is practical to use the tubular type of gage glass. In considering this curve, of course, it must be remembered that it has been plotted from a somewhat limited number of plants. It is entirely probable that additional data would change the shape and location of the curve. Nevertheless it indicates that the average life of boiler gage glasses is largely influenced by the steam pressure to which they are subjected.

The principal troubles reported with gage glasses may be summed up as follows:

1. Breakage, due to various causes.
2. Glasses becoming cloudy or opaque.
3. Glasses thinning out on top inside surface.
4. Gasket troubles.

Many reasons were given for gage glass breakage, but as a general thing faulty installation is given as a common cause for much of the early breakage experienced. Fittings may be out of line, the gland nuts may not fit properly or the gaskets may be too hard or may be screwed up too tight. Practically every one of the plants reporting emphasized the fact that all these points require attention if a short life of glass is to be avoided. The presence of cold drafts is another reason given for breakage of the glasses. As one engineer points out,

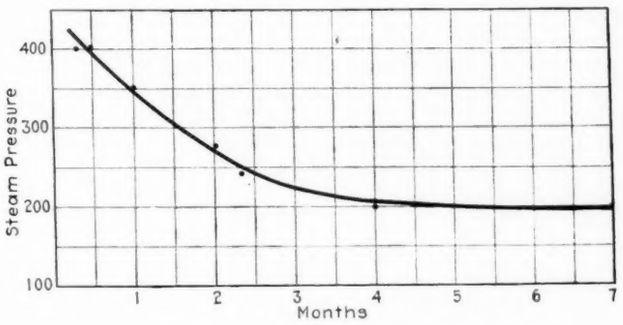


Fig. 1—Influence of steam pressure on average life of gage glasses

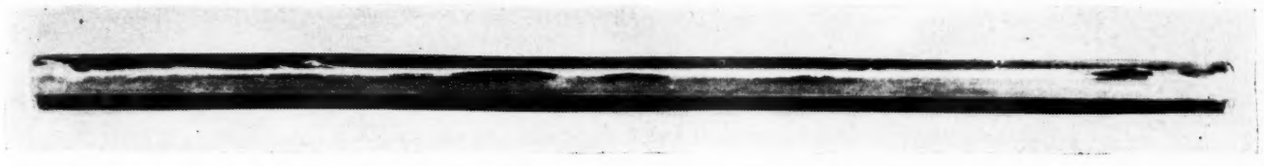


Fig. 2—Pyrex tube of thick wall and small inside diameter removed from service because of lengthwise crack

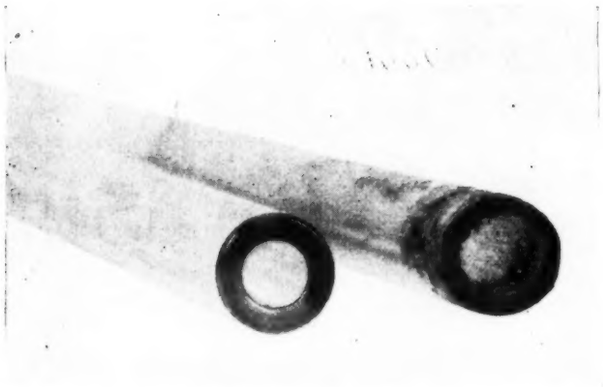


Fig. 3—Left view: New Pyrex tubular gage glass with medium thickness walls; right view: Pyrex tube similar to left view, but removed after 30 days' service at 400-lb. pressure

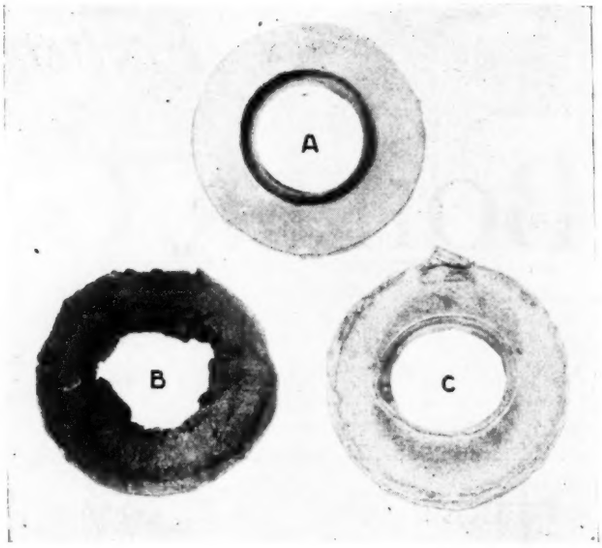


Fig. 5—A, new rubber gage glass gasket; B, top gasket, and C, bottom gasket after glass had blown out

however, practically all drafts of this kind can be shut out by the proper shielding of the glass.

Glasses that have extremely thick walls seem to have a tendency to split down one side, as illustrated in Fig. 2, which shows the lengthwise crack that made the removal of the tube necessary. Another plant reports that, from its experience, glasses that have been cut off in the plant to the proper length, seem to fail sooner than ones that have not been cut. One 1,200-lb. installation has had considerable trouble from numerous cracks in the glasses which, however, did not blow out.

Although the opaqueness of the glass after a certain period of use seemed to be responsible for the necessary replacement of many tubes, no large amount of trouble was reported due to this. In one plant, however, two-thirds of the glasses in use were replaced regularly on this account. In this particular plant the loss of tubes from breakage in service was very low and the average life was fairly high.

In the flat type of gage glass used for high pressures, the inside surface of the glass is usually protected from actual contact with the steam and water by a sheet of mica, which after a time tends to become cloudy. It is then necessary to take the gage apart, clean the mica or peel off a strip. If the mica sheet becomes broken so that the steam comes in direct contact with the glass it becomes cloudy or opaque much sooner than when the glass has the protection of the mica.

Considerable difficulty is experienced with the gage glasses for high pressures because of the thinning out of the inside upper surfaces of the glass. Figure 3 shows the ends of two Pyrex tubular glasses, one of which was new and never used and the other removed after 30 days' service. Figure 4 shows side views of the same tubes. The thinning out at the end and the effects of the dissolving action in streams parallel to the length of the tube are shown very clearly. This thinning action is thought to be due to the ability of pure water at high temperatures to dissolve appreciable amounts of glass. The steam condensed in the glass forms exceedingly pure water, which trickles down the inside of the glass. As the water flows over the sur-

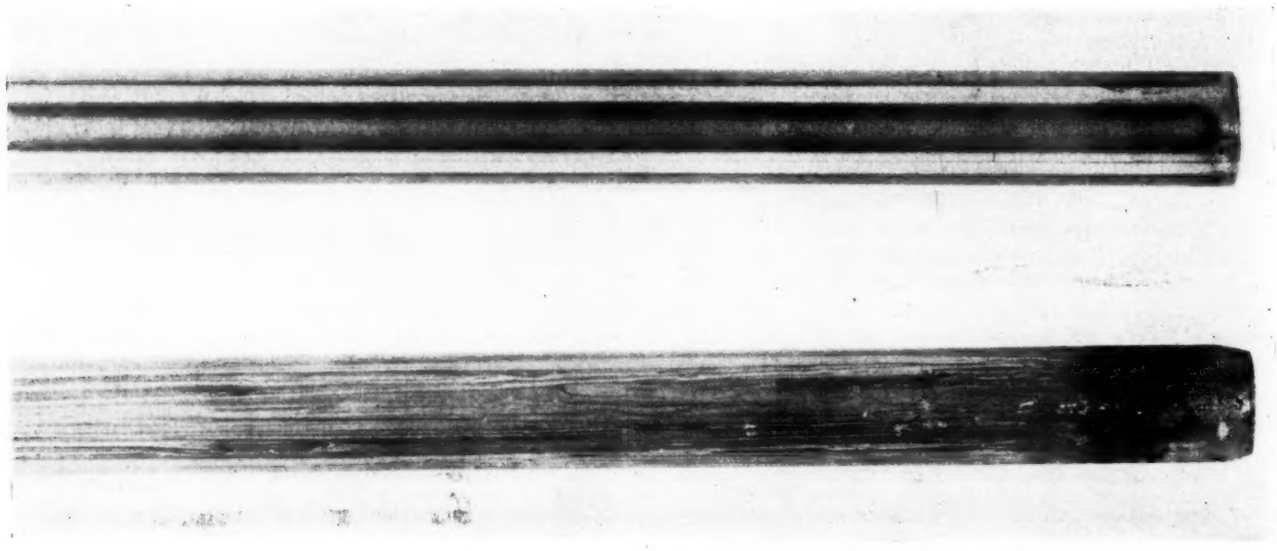


Fig. 4—Side views of tubes shown in Fig. 3
The lower tube shows the dissolving action in steam lines parallel to the length of tube.

face, some of the glass is dissolved, causing the eroded appearance evident in Fig. 4. This dissolving action apparently stops at the water line. In the flat type of glass this difficulty has been prevented to some extent by the use of the mica sheet, but up to the present time there has been reported no successful remedy for this trouble in tubular glasses.

Experiments have been tried with tubular glasses in which the upper inside surfaces were silvered, but after a short period of use, averaging about three days, the silver plating had entirely disappeared. Special tubes of Pyrex glass have been tried with an indication that these stand up better than the glass ordinarily used. Quartz tubes have also been used, and while they have proved more satisfactory than glass tubes, the cost makes the use of them practically prohibitive. Experiments have also been tried in which a heating element is inserted in the upper fitting of the glass so as to keep the steam superheated at all times. Various other plans have been suggested, but apparently no satisfactory solution on a commercial basis for the trouble has been found.

Gaskets, if properly selected and installed, seem to give little or no trouble. Most gasket troubles reported were the direct result of improper installation. In one plant, however, operating at 300 lb. pressure, considerable difficulty was experienced with rubber gaskets, which had a tendency to soften and flow out between the nut and the glass. A gasket composed of alternate layers of rubber and canvas was substituted and stopped the trouble. In another plant a combination of brass washer, rubber gasket and fiber gasket is being used with good success. The rubber gasket is placed between the fiber gasket and the brass washer with the fiber gasket on the pressure side. Several sizes of fiber gaskets and brass washers are used and are selected so as to insure a close fit around the particular tube being installed.

The important problem that now remains to be solved in connection with gage glasses for high-pressure service is that pertaining to the thinning out of the glasses at the upper end. It is hoped, however, that a practical solution, which can be applied on a commercial basis, will be found before long.

ANSWERS to "What Do You Know"

The questions are on page 900

Ans. 1—It has been found that heat can be produced by the expenditure of other forms of energy and other forms can be produced by the expenditure of heat. One is safe, then, in saying that heat is a form of energy.

Ans. 2—James Watt. His pumping engines had to compete against the horse lift, and so he expressed his engine's capacity in terms of the power delivered by a horse, assuming that a horse would lift 33,000 lb. of water one foot per minute.

Ans. 3—No. If a spark is made, its strength has no influence, but the location and the number of spark plugs do influence the rapidity and completeness of combustion.

Ans. 4—The Todd engine had the undirectional flow and the exhaust ports, but did not include steam-heated heads. The Stumpf patents included both.

Ans. 5—The absorption system requires about five times as much energy, but the energy is in the form of steam, while the energy for the compression plant must first be converted into mechanical and then into electrical energy with the accompanying large losses. Theoretically, the absorption system is the more efficient.

Ans. 6—As thin as possible; the bricks should be dipped into the mortar and laid up as close as possible.

Ans. 7—The Howden system used on shipboard. This consisted of a sheet-metal wrapper about the Scoleb marine boiler, making an air space around the boiler. Air for combustion was forced through this space and into the furnace.

Ans. 8—Dugald Clerk developed the two-stroke-cycle engine in 1878, using a separate cylinder for the scavenging and charging of the power cylinder.

Ans. 9—Dr. Arthur M. Greene is Dean of the School of Engineering.

Ans. 10—It is not the highest by some inches.

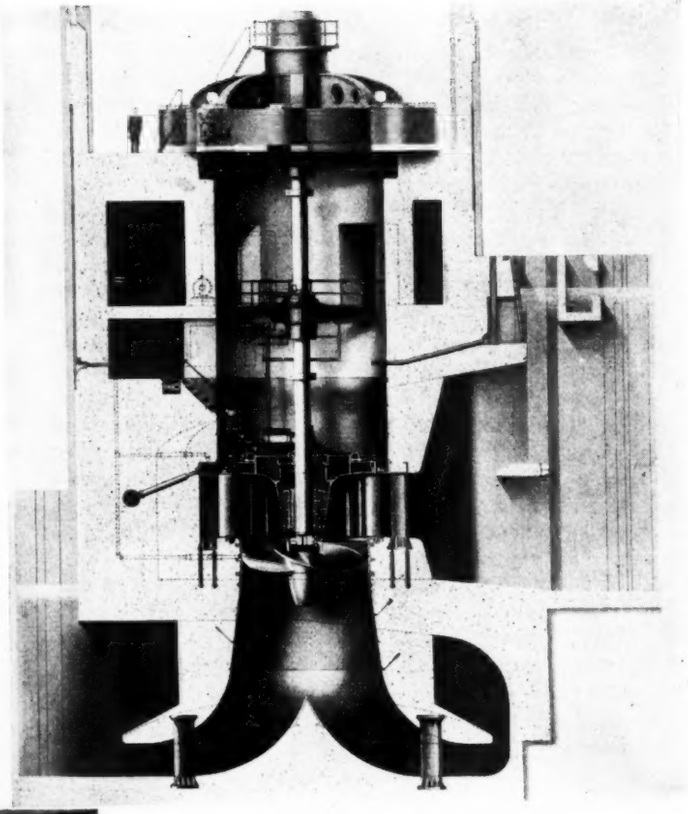
Power's Future Prophesied One Hundred Years Ago

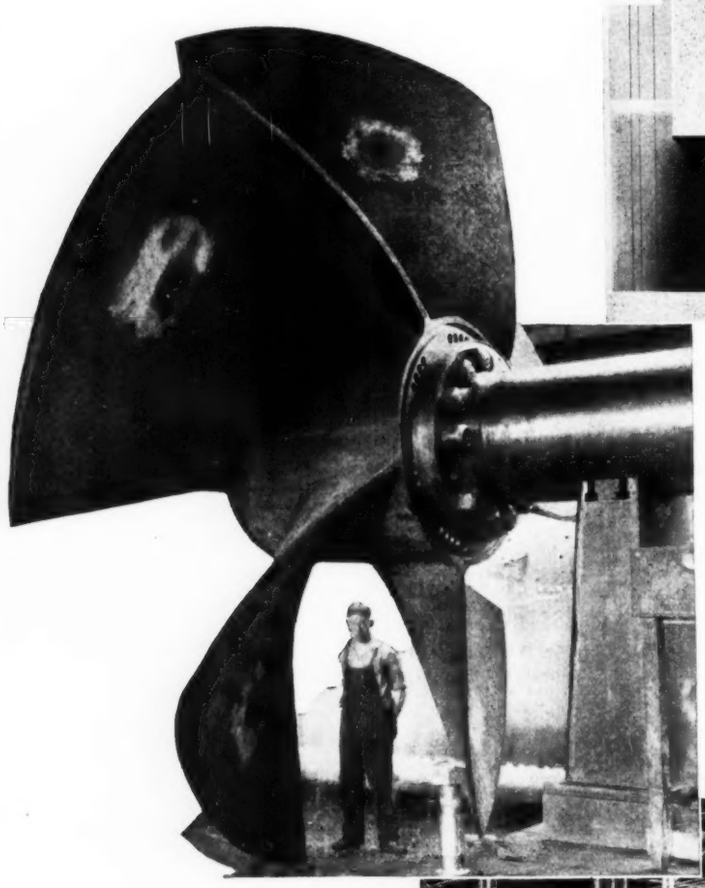
By the admirable contrivances of Watt and Fulton, the steam engine has become a thing stupendous alike for its force and flexibility,—for the prodigious power which it can exert, and the ease, and precision, and ductility with which it can be varied, distributed and applied. The trunk of an elephant, that can pick up a pin or rend an oak, is nothing to it. It can engrave a seal, and crush masses of obdurate metal before it,—draw out, without breaking, a thread as fine as gossamer, and lift up a ship of war like a bauble in the air. It can embroider muslin and forge anchors,—cut steel into ribands, and impel loaded vessels against the fury of the winds and waves. It has armed the feeble hand of man, in short, with a power to which no limits can be assigned; completed the dominion of mind over the most refractory qualities of matter; and laid a sure foundation for all those future miracles of mechanic power which are to aid and reward the labor of after generations.

Quoted from "The Literary and Scientific Class Book," by Rev. John Platts, Doncaster, England, 1821, being part of Lesson No. 26, entitled: "The Diving Bell and Steam Engine."

Head Makes the Difference

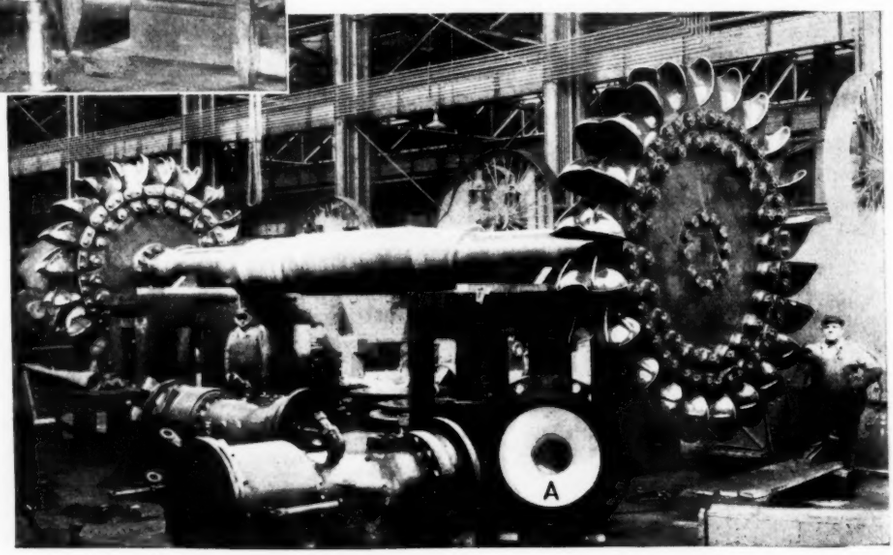
One twentieth of the water produces 200 per cent more power





Above—Cross-section of one of the seven units installed in the Falls of the Ohio Hydro-Electric plant at Louisville, Ky., described in the Feb. 7 issue. On the left is one of the runners, which are 15 ft. in diameter. These units operate under a 37-ft. head, develop 13,500 hp. and require 3,850 cu.ft. of water per second. To allow this water to flow to the runner, the area between the wicket gates is 270 sq.ft. The water flowing through the gates has a velocity of ten miles an hour. Compare this with the unit below.

Photographs by courtesy of the Allis-Chalmers Mfg. Co.



Right—Bucket wheels for 40,000-hp. impulse wheel for the King River Development (see Power, *Jan. 18, 1927). This unit operates under a head of 2,243 ft. and requires only 190 cu.ft. of water per second, which flows to the wheels in two jets having a total cross-section area of about one-half a square foot and a velocity of 250 miles an hour. One of the nozzle plates is shown at A.*

SOLID FUELS

Available for Steam Production[*]

By A. A. Potter and H. L. Solberg

Dean of Engineering, Purdue University

Ass't Prof. of Mechanical Engineering, Purdue University

This is the second of a series of articles dealing with the availability of different fuels, their classification, selection, properties and utilization.—*Editor*

PRACTICALLY all the anthracite, or "hard coal," used in this country is mined in three counties in eastern Pennsylvania. Small deposits of little importance are found in Rhode Island, Colorado, New Mexico and Alaska. It is a "luxury" coal and is sold primarily for domestic heating. It is a dense, black coal with a semi-metallic luster and burns without softening or swelling and with little flame or smoke. The average composition of anthracite on an "as received" basis is as follows: Fixed carbon, 78 to 90 per cent; volatile matter, 2 to 8 per cent; ash, 2.5 to 15 per cent; moisture, 1.3 to 6 per cent; sulphur, 0.4 to 1.0 per cent; B.t.u. per pound as received, 12,500 to 14,200 B.t.u.

Anthracite has been produced by enormous thrust pressures and is found in rock formations that are badly bent or folded. Much of it has been crushed during upheavals of the earth's crust so that as high as 35 per cent of it is in sizes too small for the domestic trade. Anthracite is screened at the mine to the sizes as shown in Table I.

Approximately 60 per cent of the anthracite is domestic size, 30 per cent is steam size, and 10 per cent is pea size. There is a growing tendency to include the pea coal in the domestic sizes.

Owing to the badly broken nature of the coal bed and the rock formations inclosing it, as much as 40 per cent of the material hoisted from the mines may be rock and slate. This material is separated from the larger sizes of coal by hand picking as the coal passes along a conveyor belt. The smaller sizes are often washed to reduce the ash content. Washing is carried on more extensively in the anthracite region than in any other coal region in the country. Unless considerable care is exercised in mining, grading and cleaning the coal, the ash content may be very high, especially in the steam sizes, where 25 per cent ash is not unusual.

TABLE I—SIZES OF ANTHRACITE COAL

	Trade Name	Round-Mesh Screen Diameter of Hole in inches Passes Through	Round-Mesh Screen Diameter of Hole in inches Passes Over	Square-Mesh Screen Size of Hole in Inches Passes Through	Square-Mesh Screen Size of Hole in Inches Passes Over	Per Cent of Total Output Included in Size
Domestic Sizes	Grate or Broken	4½	3½	4	2¾	6.2
	Egg	3½	2½	2¾	2	13.5
	Stove	2½	1 9/16	2	1⅜	18.2
	Nut	1 7/16	⅝	1⅜	¾	23.5
	Pea	⅝	9/16	¾	½	9.2
Steam Sizes	Buckwheat No. 1	9/16	5/16	½	¼	12.4
	Buckwheat No. 2 (Rice)	5/16	3/16	¼	⅛	4.2
	Buckwheat No. 3 (Barley)	3/16	..	⅛	..	12.8

In the past the refuse from the mines and washeries has been dumped in enormous "culm banks" which are now being reworked to recover the coal they contain. It was estimated that there were 20,000,000 tons of recoverable coal in small sizes in the culm banks of the anthracite region in 1924.[1] This "anthracite culm," when recovered, is small in size and high in ash, but it is used quite extensively near the mines.

*All rights reserved by the authors.

[1]Report of Giant Power Survey Board of Pennsylvania (1925).

About 600,000 tons of small sizes of anthracite are recovered yearly by dredging the streams in the anthracite region. This coal is discharged into the streams with mine and washery water or is washed from the culm banks by rain water. If proper care is used in dredging and preparing this "river coal" for the market, it is a suitable fuel for the generation of steam.

In general, it may be said that only those sizes of anthracite which are too small for the domestic trade are available for steam coals. They are high in ash and can be burned most successfully only on stokers especially designed for them. Because of their limited amount they are available as steam coals only in the regions adjacent to the mines.

Semi-Anthracite

Semi-anthracite is somewhat lower in fixed carbon than anthracite, crumbles readily on heating and emits a small amount of yellow flame when ignited. It is relatively unimportant and the small amount mined is generally masquerading on the market under the name "anthracite."

Semi-Bituminous Coal

Semi-bituminous coal is mined on the eastern edge of the Appalachian coal field in Pennsylvania, Virginia and West Virginia. Pocahontas, Georges Creek and New River coals are of this type and have the following analysis "as received": Fixed carbon, 64 to 80 per cent; volatile matter, 14 to 22 per cent; ash, 2 to 10 per cent; moisture, 1 to 5 per cent; sulphur, 0.5 to 2 per cent; B.t.u., 13,000 to 15,000 per pound.

These coals are among the finest steam coals in the world and are also used extensively for domestic heating. They have a higher heating value than any other rank of coal because of their high available hydrogen content, and are smokeless when burned properly. They are brittle and friable, so that they do not stand shipment or handling without considerable breakage. These coals are of the caking type; that is, when heated, they swell and fuse together into a solid mass which must be broken up if they are to be burned satisfactorily. The ash is refractory, and the ash content is low so that the clinker troubles are not encountered if the coal is fired properly. The supply of these fuels is limited, being only about twice as great as our anthracite resources. Because of their high heat value and general adaptability to all uses, the exhaustion of the supply of semi-bituminous coal will be a more serious matter than the exhaustion of the anthracite resources.

Bituminous Coal

The bulk of the coal mined in the United States is bituminous. It comes mainly from three fields: The Appalachian, Eastern Interior and Western Interior fields. The Appalachian field extends from Western Pennsylvania, and Ohio through West Virginia, eastern Kentucky and Tennessee to Alabama. The coals produced in this region are commonly called Eastern Bituminous Coals and are the best grade of bituminous coal that is found in the country. The coals from the Eastern Interior field, which includes western Kentucky, Indiana, Illinois and Michigan, are of medium quality. A poorer grade of bituminous coal is found in the Western Interior field, which extends southward from Iowa through eastern Kansas and Oklahoma and western Missouri and Arkansas to Texas. The coals from the Interior fields are often called "Western Coals."

On account of their wide distribution the bituminous coals show marked differences in their composition and behavior during their combustion. In general, the quality of the coal decreases as one travels westward, although some local deposits of excellent bituminous coal are found in the Rocky Mountain region. The analysis "as received" of typical Eastern and Western bituminous coals is about as follows:

	Eastern Bituminous	Western Bituminous
Fixed carbon, per cent	50-64	38-55
Volatile matter, per cent	26-38	26-40
Ash, per cent	5-12	5-20
Moisture, per cent	2- 9	8-20
Sulphur, per cent	0. 5-3	2-6. 5
B.t.u. per lb.	12,500-14,500	9,000-12,500
Softening temperature of ash, Deg. F.	2,300- 2,900	1,900- 2,400

The coals from the northern half of the Appalachian region, often called "Pittsburgh" coals, are coking coals with ash of medium fusibility. Many of the coals from the southern half of the Appalachian region are free-burning coals; that is, they show no tendency to swell and cake into a solid mass when heated. The Western bituminous coals are high-ash, high-moisture, free-burning coals. As a class they are high in sulphur and have an ash that is easily fused to form bad clinkers unless properly fired. Installations intended to burn these fuels require furnaces or combustion chambers of ample size if these coals are to be burned without producing objectionable smoke.

Cannel coal is a special grade of bituminous coal which is unusually high in volatile matter, particularly hydrogen. On this account it can generally be kindled by a match and burns with a bright flame. This coal is believed to have been formed by the collection in the open water of the swamps, of the spores or seeds of the coal forming plants. It is free from woody material and is uniform in structure in contrast with the bands that occur in most coal beds. Because of its high volatile content, cannel coal is used mainly in the manufacture of illuminating gas and in domestic grates.

Sub-Bituminous Coal and Lignite

The sub-bituminous coals are found extensively in the Rocky Mountain district and constitute one of our largest deposits of fuel. They are often called "Black lignites" to distinguish them from the true lignites or "brown coals." The analyses of these coals, "as received," are about as follows: Fixed carbon, 36 to 48 per cent; volatile matter, 24 to 36 per cent; ash, 4 to 25 per cent; moisture, 7 to 30 per cent; sulphur, 0.5 to 3 per cent; B.t.u. per pound, 7,700 to 11,000.

Sub-bituminous coals can be distinguished from the poorer grades of bituminous coals by their action during shipping and open-air storage. Bituminous coals can be stored for long periods of time without serious disintegration or loss of heating value. Sub-bituminous coals, on the other hand, are high in moisture when mined and rapidly lose this moisture on exposure to the weather, with a consequent shrinkage, checking and disintegration of the lumps along plane parallel with the bedding. This "slacking," as well as a strong tendency toward spontaneous combustion, makes it difficult to store these coals satisfactorily. They are often shipped in boxcars in order to prevent disintegration of the lumps. The moisture and ash content are excessively high. The resulting low heating value, together with the rapid "slacking" of the coal when stored, have limited the use of sub-bituminous coals to localities adjacent to the mines.

The term "lignite" as used by the Geological Survey refers to those coals that are distinctly woody or clay like

in appearance and brown in color. Their average analyses, "as received," are as follows: Fixed carbon, 15 to 35 per cent; volatile matter, 23 to 35 per cent; ash, 4 to 12 per cent; moisture, 25 to 45 per cent; sulphur, 0.5 to 2.5 per cent; B.t.u. per pound, 6,000 to 8,000.

On account of their high moisture content, shipping and handling charges must be paid on about two tons of lignite in order to secure the same number of heat units as can be obtained from one ton of high-grade fuel. Also, lignites slack or crumble on exposure to the weather and readily ignite spontaneously. They can be burned successfully only in furnaces specially designed for high-moisture fuels. These factors have practically prohibited the use of lignite except in regions close to the few developed mines. Enormous deposits of lignite are found in North Dakota, Montana, Wyoming, Colorado and Texas. As these fields are generally located at long distances from sources of high-grade fuels, the development of the lignite fields as a source of fuel is a problem of considerable importance. Experiments conducted by the Bureau of Mines[2] indicate that lignite can be carbonized and the residue briquetted to produce a fuel of excellent quality.

Characteristics of Peat

Peat is partly decomposed vegetal matter in the first stage of coal formation. Although it is used as a fuel to a limited extent in Europe, it is improbable that it will be of any economic importance in this country for many years to come because of our extensive coal resources. It usually contains from 80 to 90 per cent of moisture, so that it cannot be used without some preliminary treatment to reduce the moisture content. The moisture may be reduced to 50 or 60 per cent by pressure and to 30 or 35 per cent by drying. Dried and compressed peat in the form of briquets is a satisfactory fuel, but the cost of preparation is excessive. The heating value is between 9,000 and 10,000 B.t.u. per pound of dry peat.

Waste fuels are byproducts of manufacturing industries and are not listed as commercially marketable fuels. For many years the disposal of these fuels represented a serious problem before it was discovered that they could be burned in suitably designed settings and used for the generation of steam. They now displace several million tons of coal annually. Most of the problems encountered in using these fuels are due to their bulk and high moisture content. Some of these fuels are two-thirds moisture by weight. Since 10 per cent of moisture reduces the useful or available heating value of a fuel about 12 per cent, it is difficult to secure either efficiency or capacity with these fuels. In some installations the hot gases leaving the boiler are utilized to dry the fuels somewhat and thereby make it more easy to handle them.

Spent tanbark is the fibrous residue of the ground oak or hemlock bark used in the tanning industry. The heating value on a dry basis is about 9,000 B.t.u. per lb. As the moisture content is from 60 to 70 per cent, the available heat of the wet bark is only about 2,500 B.t.u. per lb. The moisture content may be reduced about 7 per cent by the use of presses. Considerable trouble is encountered in burning this fuel with sufficient rapidity to generate very much steam in a boiler. Tests conducted by the Bureau of Mines[3] indicated that the addition of one pound of coal to six pounds of tanbark increased the boiler efficiency from 59.4 per cent to 63.4 per cent and the rating from 92 per cent to 135.5 per cent.

Wood in the form of sawdust, edgings, cut ends, shavings, blocks and scraps is available in the lumbering districts. Freshly cut wood contains about 45 per cent of moisture, but on air drying, this is reduced to from 15 per cent to 25 per cent. Dry wood has a heating value of 7,500 to 9,000 B.t.u. per pound. "Hogged fuel" is a term applied to the sawmill refuse which is shredded to reduce it to a minimum size. Better results are obtained by burning hogged fuel than can be obtained when the fuel contains blocks and slabs and other pieces of unequal size. In some localities sufficient waste wood exists to supply the heat and power requirements of the mills and to light the town. Even then, large quantities of excess material is destroyed in order to dispose of it.

Bagasse is a byproduct fuel resulting from the manufacture of sugar. The ripe cane is crushed in powerful mills to extract the juice. The remaining fibrous material, known as bagasse, is fired to produce the steam required to operate the plant. Sugar cane has a fiber content of about 10 per cent. In addition to the fiber, bagasse may contain some sucrose, glucose and gum, all of which are combustible. The moisture content is generally between 40 and 55 per cent. The average heating value is about 8,300 B.t.u. per lb. of dry bagasse, but the moisture reduces this to about 4,000 B.t.u. per lb. as fired. Under favorable conditions enough bagasse is produced to supply the fuel requirements of the sugar mill, but under ordinary conditions it must be supplemented.

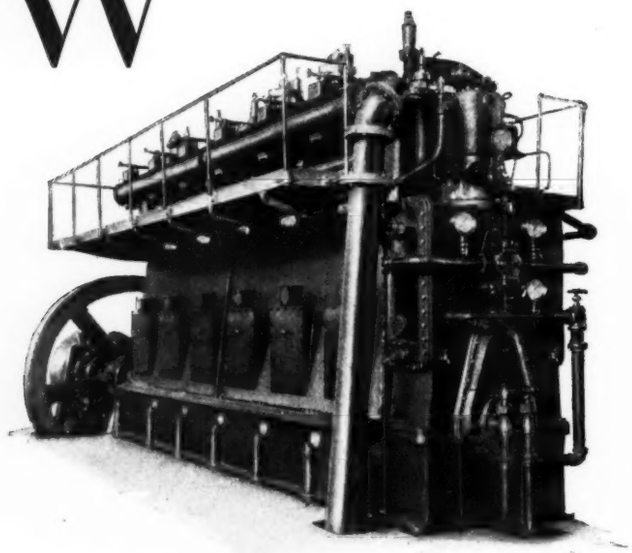
[2] Bulletin 255, United States Bureau of Mines.

[3] Bureau of Mines Technical Paper 279—"Economic Combustion of Waste Fuels."

Taking Stock—Annually

IN JOURNALISM, as in business, annual stock-taking is necessary. So, once each year, *Power* records the outstanding advances of a past twelve-month and brings itself and its reader up-to-date on practice in the supply of power services. Formerly, this was done in the first month of the year. In 1928 this review issue is timed to coincide with the annual meeting of the National Electric Light Association. This will be the next issue, dated May 29.

WRITING SPECIFICATIONS *for a* DIESEL PLANT



By V. A. Stout

Consulting Engineer, San Francisco, Calif.

IN THE purchase of oil engines too little attention is given to the matter of accessories to be furnished by the engine builder. Recently, a large transportation company had occasion to purchase twenty-four 400-hp. Diesel engines driving electric generators. Their specifications covering these engines read about as follows: "There shall be provided twenty-four Diesel engines of four hundred horsepower each arranged for driving generators as hereinafter provided."

Later on in the specifications, which in their final form comprised several hundred pages, some mention was made of the pumps and special mufflers which were to go with these engines, but the quotation given was all that really applied to the engines proper. I grant that this seems absurd, but it is an actual circumstance and shows clearly the lack of knowledge about design of Diesels and the accessory equipment necessary to their satisfactory operation. There were pages of electrical specifications and for other tools and equipment, but the Diesel engine and what was required to make it an operating entity were passed over as lightly as indicated.

The bids this company received from nineteen Diesel bidders were interesting, covering, as they did, everything from a complete engine with every necessary accessory to just the bare engine with the bare pumps, air-starting compressors and mufflers, as specified.

This may sound like a rare exception, and yet within the last year I have checked over bids on Diesel engines ranging from 600 to 800 hp., where some of the bids omitted air-starting sets and circulating-water pumps merely because the specifications did not call for these necessary accessories. The bidders wisely figured not to load their prices with anything except what was called for by the specifications. In some bids, engines offered were far superior to others as operating entities, in that they had indicating reducing motion built in as standard equipment for each cylinder, as well as air-starting valves on each cylinder arranged for low-pressure starting. Yet there was nothing in the specifications calling for these desirable features or giving credit to those engines so equipped. Usually, the manufacturer, in offering his engine, includes enough accessories so that it can be started and operated. However, none of those niceties which go to make a complete engine room and which are so important in reducing the operating and maintenance costs, can possibly be included in an initial bid unless they are actually called for in the specifications. Consequently, it is strictly up to the purchaser to be sure that he is getting everything he needs, all included in the original bid price. We hire architects to write specifications for buildings so that there will be no extras after the bids are opened, and yet, in buying Diesel engines we trust specifications like those quoted to get us a complete and satisfactory job.

In drawing up a set of specifications covering an engine for a specific purpose, one must know what to include and what to omit. The use of the engine must be carefully considered. It would be absurd to include the same accessories for an engine to be used as a stand-by unit, possibly operating 60 days in a year, as for an engine to be operated 18 to 24 hours a day, 90 per cent of the year.

The manufacturer usually furnishes the bare necessities

WHEN BUYING an oil engine many do not know what equipment should be added to the bare machine. The author tells you what an engine needs and why certain accessories are necessary.

of accessory equipment. All Diesel engines must be air-cranked to start; fuel oil must be delivered to the injection nozzles; working parts must be lubricated; cylinder walls, heads and sometimes pistons must be cooled; and the noises of the exhaust must be muffled if not silenced. Consequently, a muffler, circulating water pump and air starting set are furnished. A day

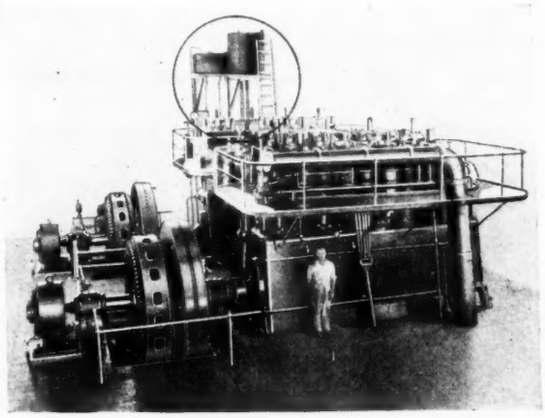


Fig. 1—The day fuel tank and the lubricating oil tank are above the engines

tank of such size that it will hold enough fuel oil for 24 hours of operation, the fuel-oil pumps which will take oil from the day tank under a constant head and deliver it to the fuel valves, the lubricating oil pumps, and the lubricating oil sump tanks are all so closely related to the operation of the engine that they are a part of it. Special tools, such as wrenches, barring devices, piston-ring clamping and inserting tools, bearing gages and other similar equipment, cannot be purchased except through the manufacturer, and it is quite the usual thing for this equipment to be included with the engine. Certain small wearing parts that may need to be replaced at any time are usually supplied.

Handling the Fuel Oil

But the manufacturer is not always interested in seeing that the fuel oil is properly conveyed from the main storage tanks to the day tank in the engine room. Nor is he interested in seeing that proper heating of the fuel oil is arranged for, so that viscous oils, particularly those with an asphalt base, will flow freely at all times, regardless of the weather. Yet these two functions of Diesel engine operation are as important as cooling of the cylinder walls or the silencing of the exhaust gases.

The necessity of a fuel-oil transfer pump in any Diesel-engine power plant cannot be questioned. A rotary or gear pump of the internally lubricated type, motor-driven, meets all the requirements of the case. A capacity of 25 gal. per min. against 25 lb. pressure, assures that a 600-hp. engine will operate 40 hours if the pump is operated one hour per day. The cost of such an outfit should not exceed $125, but it should be included with the engine and ordered with it as an integral part of the accessory equipment.

The assurance of free-flowing fuel oil under all climatic conditions is a more complicated problem. Burning low-gravity oils in a Diesel assures us of low fuel-oil costs, regardless of conditions of the oil market. The burning of 28-deg. Baumé Diesel oil may be prohibitive. Provision should be made for heating the fuel oils either by hot water from a special heater in the exhaust line, or by hot water from the exhaust-gas boiler. Coils in the muffler can also be used, as will be explained later. The specifications for such a hot-water heating system from one manufacturer, read as follows:

> The company is prepared to supply a jacketed oil reservoir located on the side of the injection pump and provided with a small additional compartment for light oil, which latter is to be used in starting the engine and is regulated by a switch valve. Hot water will be supplied from a special heater placed in the exhaust line, and circulating pump will be supplied.

This equipment, including the jacketed oil reservoir, switch valve, special heater and circulating pump, was offered at a cost of about $500 and was guaranteed to assure the satisfactory operation of a 200-hp. engine on Mexican crude oil.

The Lubricating Oil System

If the lubricating oil pump is driven off the engine crankshaft, it starts when the engine starts and functions continuously and satisfactorily until the engine is closed down. If the lines become clogged, a rise in pressure on the lubricating oil gage warns the operator, and a shutdown for correction of the difficulty can be made instantly. Likewise, a fall in pressure tells of worn bearings letting the oil through too quickly and warns of the necessity of repairs. If the lubricating pump is in-

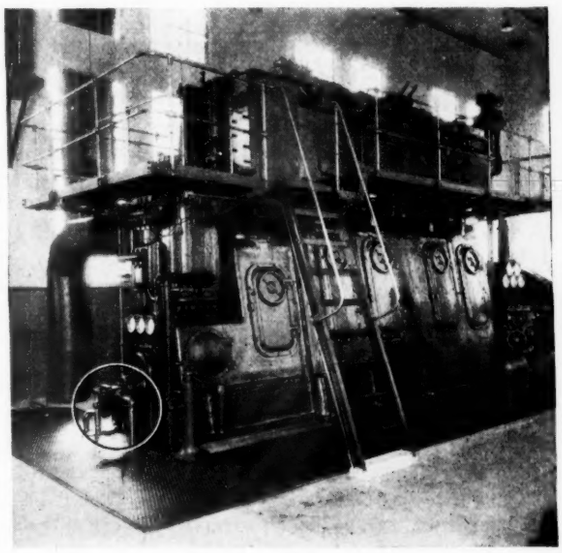


Fig. 2—The lubricating oil pump is geared to the engine

dependently driven by motor, it should be a gear or rotary pump, but a stand-by lubricating oil pump of the reciprocating plunger type, steam driven, is nice to have around. Lubrication of the running gear of the engine is essential, and sometimes the engine may have to be run with no load. When there is only one engine and generator in the plant and no opportunity to hook in on outside power, a steam-driven lubricating oil pump, with the steam coming from the exhaust-heat boiler is most desirable.

The mechanical lubricator for the lubrication of the cylinders is another story. It is presumed that as a

matter of course, no engine of any reasonable size will be furnished without such a lubricator. Whether it is timed or not, whether its sight of the drop of oil is on the suction side or on the discharge side of the plunger and whether the leads to the cylinder plugs are separate or one lead split near the cylinder, depends the satisfactory operation of the engine and its cost of maintenance. Cylinder lubrication should be timed in four-stroke-cycle engines so that the exhaust stroke, intake

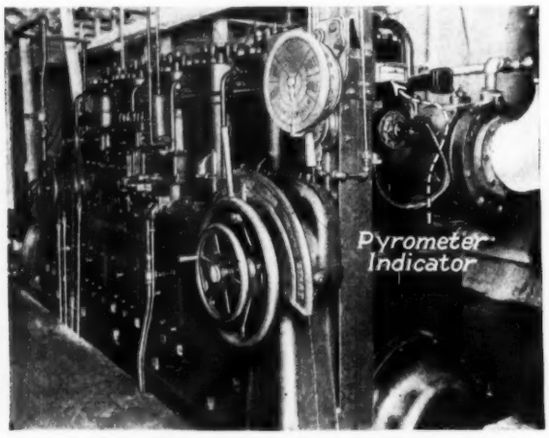


Fig. 3—A pyrometer is a necessary instrument

stroke and compression stroke come after the oil injection. Then the cylinder walls are thoroughly wiped with the oil before the heat of combustion comes. In a two-stroke-cycle engine the cylinder lubricating oil should be injected above the scavenge ports and against the piston when it is on its up stroke. This assures a minimum of oil and maximum of results, which is the best that can be expected from this type of engine where lubrication at its best is none too good.

The Mechanical Lubricator

The mechanical lubricator should show the oil drop on the pressure side of the plunger. This eliminates the chance for a plugged oil line not showing up for some time and damage being done before the trouble is caught. Finally, there should be a plunger and an individual lead for each inlet into the engine cylinder. Where one plunger and a split lead are used for two or more cylinder plugs, should one of the inlets gum up with carbon, the resultant faulty lubrication may cause scored cylinder walls or even a stuck piston before the trouble is discovered. With the oil sighted on the pressure side of the plunger and one lead from each plunger to each inlet plug, the difficulty can be discovered and corrected before damage results.

The circulating water pump is usually furnished by the manufacturer even when it is entirely independent of the engine and driven by a motor. But the cooling of the engine cylinder walls and heads and sometimes the pistons, is one of the most important details incident to Diesel operation. Broken cylinder heads may be the result of faulty design; scored cylinder walls may be ascribed to faulty lubrication; cracked piston heads in water-cooled pistons may be the result of poor design and faulty workmanship; but they can all result from hard water (that is, from the scale produced by hard water) or partial failure of the cooling water.

In an Arizona Diesel plant piston heads were so frequently broken as to be a major item of expense. A water-softening system was in use. It was finally determined that the joints carrying the water into the piston rod had a tendency to plug with chemicals until the water supply to the piston head was entirely cut off. Then the plug would let go and the cold water rushing against a red-hot piston head caused the trouble. Using distilled water for piston cooling avoided the danger of scale and also corrected this difficulty.

Choosing the Water System

For piston-cooling water it would appear desirable to use distilled water, which should not be difficult to obtain around a plant having an exhaust-gas boiler. By the use of distilled water in a closed system rather than the softened water from the jacket cooling system, all impurities and chemicals are kept out of the system, and the danger of clogging the joints or small water passages is avoided. By the use of heat exchangers, the small amount of water used for piston cooling can easily be cooled by the main jacket cooling water as it goes from the cooling tower sump or spray pond to the engine. A complete system such as described here, including spray pond, at least three motor-driven centrifugal pumps, heater exchanger, and water softening system has recently been installed in Arizona for a cost slightly less than six dollars per horsepower of engine capacity. It would appear that this is a safe figure to use on all plants from 100 hp. up. The smaller plants eliminate the

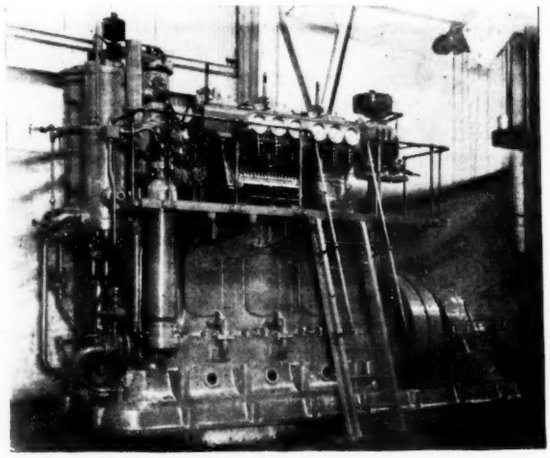


Fig. 4—The various gages should be placed in a convenient place

multiplicity of pumps, the heat exchanger, and the elaborate tower, but the remainder of the equipment makes up its greater cost.

The starting of a Diesel engine by giving it momentum by compressed air is simple and effective, whether the air be the blast air of an air-injection engine or low-pressure air separately supplied. In the former case the pressures involved are from 900 to 1,000 lb., while with low-pressure starting 250 lb. is sufficient. To start the engine in either case, when no air pressure is available, requires an independent air compressor, usually driven by a kerosene or gasoline engine. A single-stage air compressor usually suffices unless the pressures involved are

over 250 lb., and in that case a two-stage machine is desirable.

The capacity of these air starting sets depends entirely on the urgency of quick starting. Rarely, except at the beginning of operations, is the starting air completely exhausted from the storage tanks or bottles. Usually, it is only from 50 to 100 lb. below the pressure actually required to start the engine. For a 600-hp. engine most manufacturers offer a 30-cu.ft. capacity compressor, driven by an 8- to 10-hp kerosene engine. This set would appear satisfactory and assures, except at the start of all operations, against a delay greater than fifteen minutes to start the engine.

Neighborhood Objections Should Be Avoided

The type of muffler or silencer to be used depends entirely on the situation of the plant. The pot-type muffler, furnished by a great number of manufacturers of both large and small engines, is satisfactory for power plants for mines and remotely situated power stations. For the plant in town, certainly the Maxim silencer has no equal for actually silencing the noises of the exhaust. If further refinements are desired, we can go to scavenge-air intake silencers for two-stroke-cycle engines and air-intake mufflers for four-stroke-cycle engines.

Certainly, with the wide use for hot water around a plant, particularly for heating fuel oil and for sanitary purposes, the exhaust muffler should be equipped with water coils through which the water from the exhaust manifold can be led with a resultant temperature of 125 to 150 deg. F. It can be installed where it is easily accessible for cleaning out and clean-out doors provided for this purpose.

The position of the muffler is also important. I have seen an installation of a silencer on a two-stroke-cycle engine, 40 ft. from the engine and with eight right-angle bends in an eight-inch line. A light-spring indicator diagram taken from the exhaust line near the engine showed five pounds back pressure, when the scavenge air pressure of the engine was at most not over four pounds. Is it any wonder some engines do not work right? And again, there recently came to my attention an installation in which the exhaust pot was located in the base of an old brick chimney, with disastrous results to the chimney. A steel flue inside the chimney would have saved a great deal of trouble and expense.

Additional Accessories

Indicator reducing motion on small engines may be an extraordinary expense, and pull diagrams to give maximum pressure curves can be resorted to with excellent results. But every engine over 200 hp. should have each cylinder equipped with the indicator reducing motion. If a set of indicator diagrams are taken at least twice a week, troubles are caught at their inception, and a forced and undesirable shutdown can in a great many cases be avoided altogether by proper corrective methods taken in time.

Next in importance come exhaust-gas temperatures. Any sudden rise in temperature is a clear indication of trouble. A pyrometer, electrical recording, in plants over 200 hp. at the least, should be regularly connected to the engine through thermocouples in each cylinder exhaust line and the leads carried to a common instrument near the engineer's desk. For engines smaller than this limit there are mechanical pyrometers arranged to screw into the fire plug of each cylinder. They are more accurate than thermometers, and their freedom from breakage alone should recommend them. They are quite inexpensive, and for a six-cylinder engine their cost will not exceed 50 cents per engine horsepower.

Thermometers should have an important place in every engine room. By recording the temperature of the cooling water leaving each cylinder and the piston, where the engine carries this latter form of cooling, they help to keep the engine working at maximum efficiency. In oil engines, just as in all other internal-combustion engines, a cold engine is an inefficient one. A record of the temperature of the lubricating oil as it returns to the sump from lubricating the wristpins, main and crank bearings and other parts of the engine, is an invaluable aid to good engine operation. Thermometers serve to protect the engine against major breakdowns by warning the operators at the inception of the difficulty that trouble is coming.

Gages Are Needed

Gages that have the important function of showing the pressures for the fuel-oil injection, either on air blast or mechanical injection engines, are not enough. In addition, gages should be installed on the lubricating oil lines, scavenge air lines for two-stroke-cycle engines, the air starting lines of all engines, either high-pressure or low-pressure starting and on jacket cooling water lines.

None of the accessories described is non-essential. They all have a double function: First, to improve either the efficiency of the engine or its operators; and second, to insure the engine against serious damage. Their total installed cost does not exceed 5 per cent of the installed cost of any engine. Surely, this is cheap insurance if we look at this one phase alone. When we consider their effect upon the operation of the engine, they readily become indispensable.

In this article the equipment most likely to be included by an engine builder in his bid, as well as those accessories attached to the individual engine, have been discussed. A subsequent discussion to be published in an early issue will cover the equipment that serves the entire plant, such as towers, oil filters, etc., and a set of specifications will be included.

New Diesel Towboat for Mississippi River

A NEW Diesel-electric towboat, the "Tecumseh," the fourth of its kind to be built and the second of its size to be equipped with Diesel-electric propulsion, is shortly to be put in service in the St. Louis district by the United States Engineering Corps.

The power plant of this boat consists of a 300-hp. Lombard Diesel engine driving a G.E., 210-kilowatt 400-r.p.m. 190- to 315-volt generator and a G.E. 20-kilowatt 400-r.p.m. 120-volt compound-wound generator. The larger generator will supply power to two 115-hp. 360- to 600-r.p.m., shunt-wound propulsion motors, and the smaller generator will supply power for running auxiliaries and for lighting, as well as excitation for the main generator and propelling motors. The propeller is of the paddlewheel type, located at the stern, and is driven through two sets of Link-Belt chains.

HAND TOOLS

Used for

Undercutting Commutators

By H. E. Stafford

Electrical Engineer, Provincial Paper Mills, Limited

PRACTICALLY all medium- and high-speed machines operate better when their commutators have the mica between segments undercut. In the case of motors running at low speed, undercutting is not desirable, since the centrifugal force is not sufficient to clear the slots in case foreign matter becomes lodged between adjacent bars. Undercutting a commutator under these conditions will cause ring fire. A commutator should not be undercut if the voltage between adjacent bars is abnormally high.

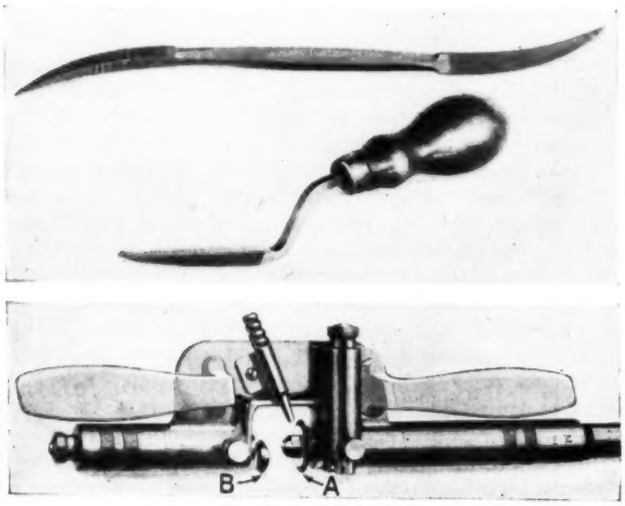
Undercutting may be done by means of a piece of hacksaw blade, a special three-cornered file, or by any of the various motor-driven undercutters which may be purchased specially made for the purpose. The cheapest tool for undercutting consists of a piece of hacksaw blade clamped between two pieces of wood. This method of undercutting is the most expensive where time is an important item, but where there is a small number of commutators and where a motor-driven tool is not warranted, the hacksaw answers the purpose.

* * * *

Fig. 1 (Below)—Double- and single-end files for undercutting commutator mica

Fig. 2 (Bottom)—Hand tool for undercutting commutator mica

Cutter *A* is motor driven through a flexible shaft. A slot guide *B* is provided, which is adjustable by a micrometer screw.



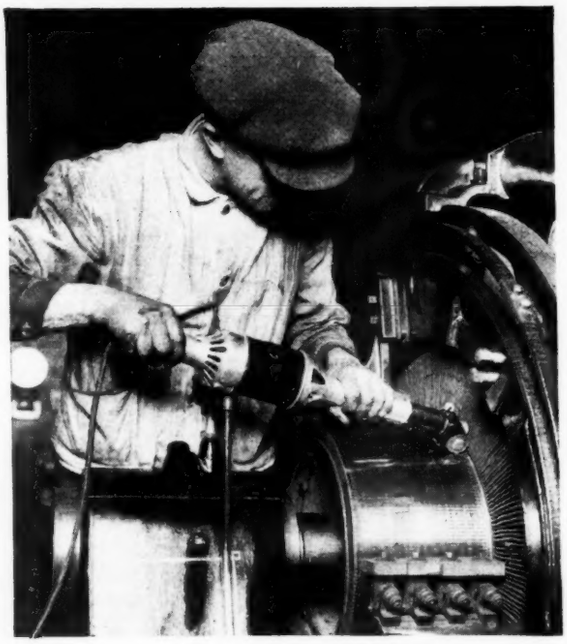


Fig. 3—Motor-driven cutter with the driving motor encased in the handle of the tool

The weight of the machine is carried by an adjustable-depth shoe on one side and a small roller on the other so that the cutter cannot cut beyond the depth to which the saw is adjusted.

Undercutting files can be obtained in either single- or double-end types. Files with a 40-deg. angle between cutting sides are used for thin mica, and 60-deg. angle files are used for standard width mica. Two types of these files are shown in Fig. 1.

There are several types and makes of motor-driven commutator slotters or undercutters, each having special characteristics. The slotter shown in Figs. 2 and 5, is supplied with either V- or U-shaped milling cutters. The cutter *A* is driven by a small motor through a flexible shaft, and the tool is provided with a slot guide *B*, adjusted by a micrometer screw.

Another type of undercutter is shown in Fig. 3. This slotter is provided with a 1½-in. circular saw keyed to a hollow mandrel that carries a gear. The gear and driving shaft are incased in the handle of the tool. The weight of the machine is borne by an adjustable-depth shoe on one side and a small roller on the other, so that the cutter cannot cut beyond the depth to which the saw is adjusted. Saws for this tool may be had in all sizes covering the standard widths of mica.

Another type of this undercutter has been developed, which is light in weight. Saws of various thicknesses are provided, and these are easily slipped on and off. It is not recommended for heavy duty or where the mica is extra wide, 0.045-in. saws being the heaviest furnished. It can be used on any size of commutator, and it is seldom necessary to remove the end bells of semi-inclosed motors when using this slotter to undercut the mica.

Fig. 4 shows a lathe-type undercutter. Where the armature is turned in a lathe, the operations of truing,

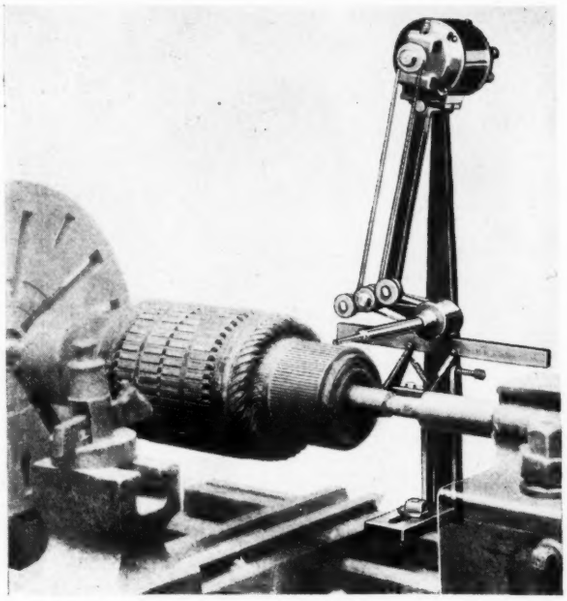


Fig. 4—Motor-driven tool for undercutting commutator mica when the armature is mounted in a lathe

undercutting and polishing can be accomplished without removing the armature from the lathe.

When V-shaped cutters are used on undercutters, it is not necessary to file the edges of the bars since, if care is used, the copper will not be jagged. When U-shaped cutters are used, some operators prefer to chamfer the edges of the bars, but from past experience this is hardly necessary.

What should be done after the undercutting is completed is to polish the surface of the commutator with a sheet of No. 00 sandpaper or, better still, use a glazing stone while the armature is rotating. The glazing stone is composed of a composition that puts a fine, smooth finish on the surface of the commutator and is recommended for use in preference to sandpaper, which usually gives the commutator a raw surface. Never use emery paper or cloth on the surface of a commutator.

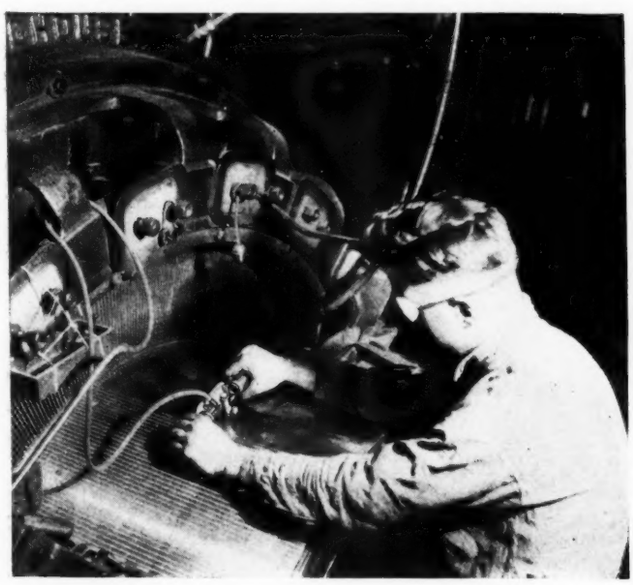
A commutator should never be allowed to become black, nor should it have a raw appearance. When blackened, there is too great a resistance between the commutator surface and the brush, while when it has a raw surface, there is a tendency to wear the brushes down and the particles of carbon and graphite will clog the brush holders and foul the brushes. This condition, in a short time, will lead to a blackened commutator. A commutator is in its best condition when it has a light chocolate color, has a medium polish and is perfectly smooth.

Commutator cement is used in filling spaces between bars where the mica has been burned deep by some commutator or armature defect. The cement is highly insulating, adhesive and expands with the temperature of the adjoining copper. This cement may also be used in filling the slots of undercut commutators level with the surface of the copper, thus preventing oil and other foreign matter from entering the slots. The cement wears away much quicker than mica, and a commutator thus treated has all the characteristics of one that is undercut.

The commutator is the part of a direct-current machine that is most likely to cause trouble, but if given a little intelligent attention the possibilities of faulty operation will be practically eliminated.

* * * *

Fig. 5—Type of cutter, Fig. 2, being used to undercut the mica in a large commutator



Fifteen Pointers

On Synchronous-Converter Maintenance

By R. E. Powers

General Engineer, Westinghouse Electric & Manufacturing Company

THE machines should be well blown out with clean dry air at least once a week, while the machine is at rest. A blast of air should be directed in through each of the spokes on the commutator spider and through the spaces between the windings of the alternating-current end. The machine should be carefully wiped off after such a blowing out, and special care should be taken to see that all carbon particles are removed from the current-collecting parts.

A direct-current brush pressure should be maintained on all brushes at a uniform value of from 2 to 2½ lb. per square inch of cross-sectional area.

An alternating-current brush pressure should be maintained at a uniform value on all brushes of from 2½ to 3 lb. per square inch of cross-sectional area.

All the direct-current brushes should be gone over once a week to make sure that they move freely in their holders.

Shunts on the direct-current brushes should always be kept in well-rounded shape and never mashed down, otherwise proper brush contact on the commutator will not be obtained.

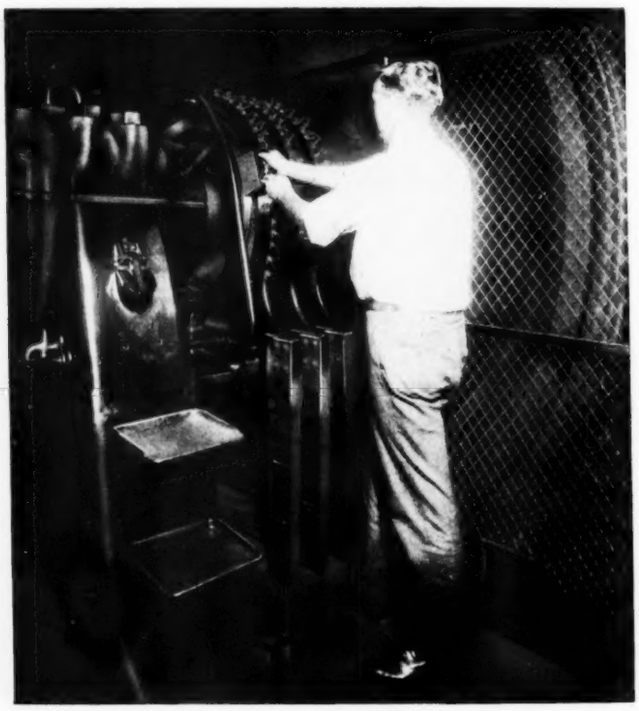
All alternating-current brushes should be gone over at least once a week and each brush removed from its holder and wiped off clean with a piece of cloth. The alternating-current brush rig should be blown out thoroughly

before resetting the alternating-current brushes in their holders for, in this manner, the dust that accumulates in the brush-holder boxes can be blown away, as it cannot be done when the brushes are in their holders. Check weekly for at least 0.006 in. clearance on each side of each brush.

Shunts on alternating-current brushes should always be kept in well-rounded shape, as already recommended in connection with the direct-current brushes.

All alternating- and direct-current brush-holders should be kept as near as possible to within about $\frac{1}{8}$ in. of the commutator and collector rings. As wear on the commutator and collector make it necessary, follow them up by changing the position of the holders.

Keep the commutator and collector rings smooth. Grinding about once a year is a good insurance for best operation, particularly on automatic units. Keep the



Grinding collector rings to give them a smooth surface

mica well undercut and bars properly chamfered. Keep the undercutting well cleaned out.

Whenever commutator flashing occurs the commutator should be smoothed up and polished with a hand stone. If the flash is of a severe nature, the commutator should be ground with a regular grinding outfit.

When motor-operated lifting mechanisms are used, they should be tried frequently to make sure that they are functioning properly, and at the same time all the direct-current brushes should be inspected to make sure that they lift clear of the commutator when in the up position and are all down on the commutator when in the running position.

On 600-volt converters it is necessary to keep the flash barriers at approximately $\frac{1}{32}$ in. from the commutator, and it is essential that the barriers should be inspected frequently and all carbon dust and copper dust should be carefully wiped from them. If there is any indication that the flash has carbonized or burned a portion of a flash barrier, it should be removed, all carbon deposit scraped or cleaned off and the barrier polished and replaced with the proper clearance.

Keep the oil in the bearings clean. Oil should be entirely drained from bearings and new clean oil inserted at least once a year. During hot summer weather, if the temperature of the oil exceeds 70 deg. C., it should be changed more frequently, as carbonization is likely at these high temperatures.

Periodic tests of insulation resistance should be made to determine the condition of the insulation.

Some commutator wear and collector-ring wear must be expected on all converters. A liberal wearing depth in current-collecting parts is provided to allow for this wear. If proper maintenance is given the apparatus, as herein outlined, a reasonable life will be obtained.

Current Transformers' Condition

Determined When in Service

A METHOD for determining the existence of short-circuited windings in current transformers, while the transformers are in service and loaded, is given in a recent report of the National Electric Light Association's Electrical Apparatus Committees. When making this test, no measurements need be made on the primary side of the current transformer. This test was devised primarily for installations where it is not possible to interrupt the service and for installations where the voltage of the primary circuit is of such a high value that it is not possible, from a safety point of view, to use split-core type current transformers for a rough ratio comparison.

It has been found, experimentally, that short circuits in current transformers are readily detected by this method, if errors of the order of 2 per cent or more occur at the watt-hour meter due to the short circuit.

It is assumed that the size, type and make of the current transformer under test is known or may be obtained. An ammeter is inserted in the secondary circuit of the current transformer, and the load current is determined. Immediately thereafter, a non-inductive resistor is inserted in the secondary circuit (see Fig. 1), and with this resistor in circuit the secondary current is again deter-

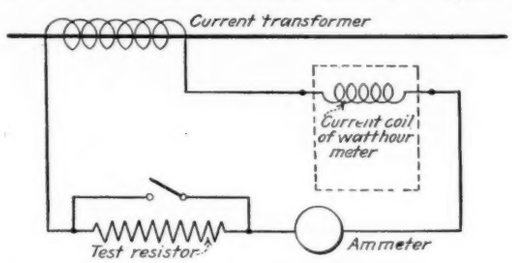


Fig. 1—Method of connecting test resistor for determining condition of a current transformer

mined. This procedure is repeated several times in order to make certain that any difference in the two current readings is not due to a change in the primary load. In each case the non-inductive resistance should be reduced gradually in order not to magnetize the core of the current transformer, which may cause a permanent change in its ratio and phase-angle characteristics.

As a result of this test two readings are obtained: First, the load current with normal burden, and second, a current with the non-inductive resistor inserted in the secondary circuit. It is assumed that in both cases the primary load current is the same. The point determined

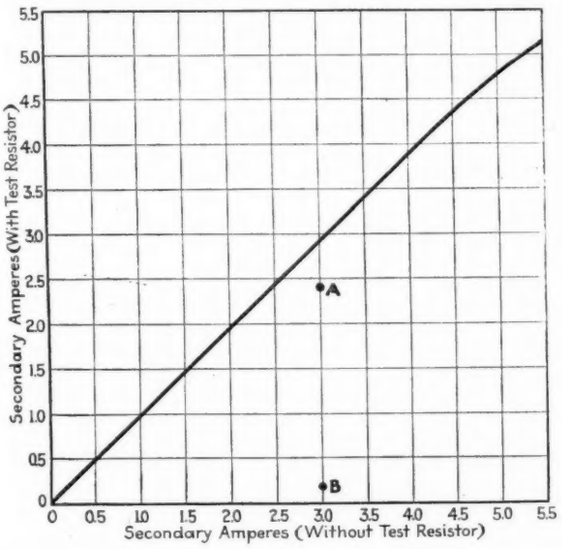


Fig. 2—Comparison of defective transformer test data with reference data

Secondary burden on the transformer, 100 ft. of No. 14 copper wire one watt-hour meter current coil and a 60.3-ohm non-inductive resistor.

by these two current readings is then compared with a reference curve for the particular size, type and make of current transformer under test. If the point falls on the reference curve, the transformer under test is free from short circuits of an order sufficient to cause errors at the meter of 2 per cent or more. If the point does not fall on the reference curve, the transformer must have a short circuit in its secondary or its primary windings.

In practice this method, when applied to defective transformers, gives results that differ widely from the standard reference curves of that particular size, type and make of transformer. In all transformers so far tested, the difference has been so marked and radical as to leave no doubt in the observer's mind as to the existence of a short circuit. As an example, the results obtained with two defective transformers are shown in Fig. 2. The reference curve, in this figure, is for a certain size, type and make of current transformer. On this figure are also indicated two test points obtained with defective current transformers of this particular size, type and make. Point *A* was obtained from test readings on a transformer with a partly short-circuited primary winding, while point *B* was obtained on a transformer with a partly short-circuited secondary winding. In both cases the partial short-circuits caused errors of approximately 2 per cent at the watt-hour meter.

Reference to Fig. 2 shows the marked difference between the test data for the defective transformers and the values given on the reference curve for the same type, size and make of current transformers.

The normal burden on the transformer consisted of 100 ft. of No. 14 copper wire and the current coil of a 5-ampere, 60-cycle, Type OA watt-hour meter, while the special non-inductive test resistor was 60.3 ohms. This odd value of resistance was used, as a resistor of this particular value was available for use in the tests made.

The success of this scheme is based on the similarity of characteristics of current transformers of the same size, type and make. It is a well-known fact that there is a very definite relation between the ratio of a current transformer and its secondary burden. This relation will change with the type, size and make of transformer, as it is fixed by the design characteristics of each type.

The procedure followed in determining a reference curve is similar to that previously described for obtaining a reading in the field. A normal burden, consisting of a current coil of a watt-hour meter and a certain amount of wire, is connected in the secondary of the transformer under test. For a given primary current the secondary current is measured. The special test resistor is then inserted in the secondary circuit, and the secondary current is again determined—the primary current still being maintained constant. This value of current is plotted against the secondary current obtained with the normal burden. The same procedure is followed for the entire range of the transformer, and the curve obtained from these readings is used as the reference curve.

Using Flashlight for Testing

By George Ludwig

AN ORDINARY battery flashlight is carried by many electricians as a handy device to make inspections in dark corners, where an extension light may not be readily available. I have extended the usefulness of my battery flashlight so that it can be used for testing fuses and low-voltage lamps and other low-voltage devices.

As shown in the figure, a hole was bored through the case opposite the lamp socket and an insulated wire was taken in through the hole and soldered to the lamp socket. When the free end of the wire is touched to the base of the battery case, the lamp will light. A fuse placed

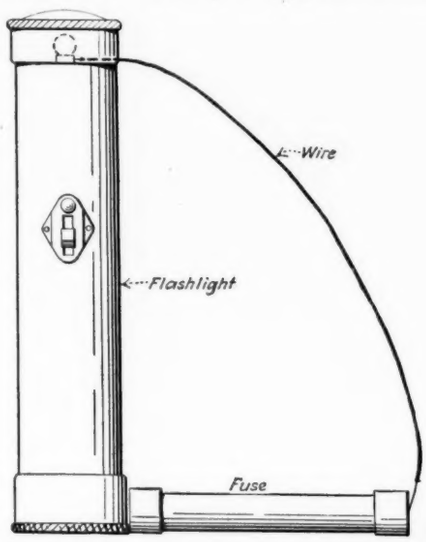


Diagram of how a flash light is used to test fuses

in the circuit as indicated can be tested as shown. If the fuse is good, the lamp will light and will remain dark if the fuse is open.

The switch in the flashlight is not changed, so that adding the wire connection does not interfere with the regular use of the flashlight. When using it for testing purposes, the switch is left in the open position.

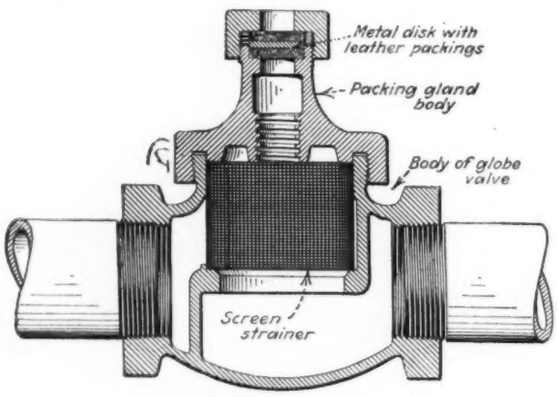
IDEAS FROM PRACTICAL MEN

For the exchange of practical information and ingenious expedients in operation and maintenance of plant and equipment

Old Valve Serves as Strainer When Fitted with Screen

A PRACTICAL strainer, which was adopted by one shop, in connection with the fuel oil supply for a furnace, is shown in the sketch. Considerable trouble was had from solid particles clogging the burner nozzles, and a strainer was necessary to remedy this situation.

An old valve, from which the stem and disk had been removed, was inserted in the pipe line. A cylinder, with



Screen fitted in valve body

one end of fine-mesh copper filter screen was then made to fit tightly in the valve body, the bonnet holding it in place. The stem opening in the bonnet was closed with a metal disk and two pieces of leather. If desired, disks of felt can be inserted in the screen cylinder and thus make the strainer more effective in removing the finer particles.

G. A. LUERS.

Washington, D. C.

Increasing Capacity of Air Compressor by Heating the Discharge Pipe

RECENTLY, we were using a heavy paving buster in removing an old foundation. As it was built of bricks laid in cement mortar, it proved tough, and its removal required constant hammering for several days. Air was supplied to the buster by a small motor-driven compressor rated to deliver 38 cu.ft. of air per minute at 100 lb. pressure. This was not sufficient volume to keep the hammer in constant operation without an undesirable drop in pressure. Moreover, the weather was cool and damp and the air, coming from the receiver through 150 ft. of pipe, was already so low in temperature that upon reaching the hammer, the additional drop in temperature due to expansion was sufficient to cause freezing of the water vapor carried by the air.

The work was thus constantly interrupted, the men being compelled to wait for the ice to thaw out of the exhaust ports. It was evident that they were wasting at least half of their time.

To eliminate this difficulty, we built around the air pipe near the hammer a fire of sufficient intensity to heat the air to a temperature as high as the connecting hose could well stand. This proved sufficient to prevent further freezing of the moisture. Another benefit derived from the heating was an increase in volume of about 20 per cent, due to our raising the absolute temperature in about this proportion. This was equivalent to increasing the compressor capacity, and enabled this machine to keep up full pressure.

With the hammer in constant operation at full pressure we were able to complete the job on time. While this little trick may seen a small matter to some and is undoubtedly known to some readers, it proved valuable to us in the matter of expediting the work and in the saving realized.

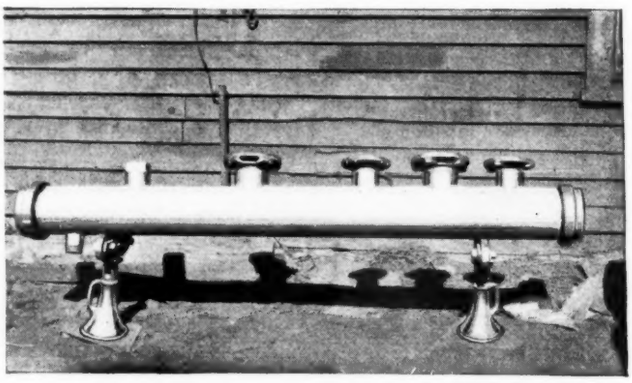
M. F. KNOY.

Lake Charles, La.

Short Header Section Simplified by Welding

THE illustration shows a job of pipe welding done on a header that is to be used in a building now being erected in this city.

The header is 6 ft. long and 8 in. in diameter. The outlet at the bottom is 2 in. Two of the risers are 3 in. in diameter, and the remaining three risers are $2\frac{1}{2}$ in. in diameter. The total time required for cutting the openings and doing all the welding was ninety minutes. A No. 64 welding tip was used and the work was done by a local welding company. The risers and the outlet were made from scrap lengths of pipe, and the cost for the



Header made from scrap by means of welding

job was approximately $20. This covered the cost of pipe, six flanges, gas and labor.

The heating contractor who installed this header estimated that, had it been made in the usual way with fittings, the cost would have been materially higher. By utilizing welding a considerable saving was effected and in addition a neater and more compact header section was obtained.

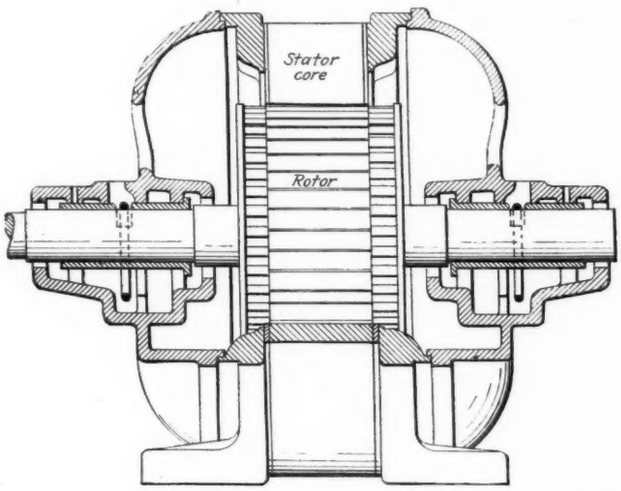
E. C. CALUWEART,
Smith Welding Equipment Corporation.

Minneapolis, Minn.

Induction Motor Rotor Pulled Toward One Bearing

THE rotor on a three-phase motor would pull endwise until the shoulder on the shaft was held tightly against one of the bearings, when it should have taken a position clear of each bearing, as in the figure. With the current off, the rotor would ease back until the shoulder on the shaft was away from the bearing.

The electrician in charge was puzzled over this action and thought that the motor might not be properly leveled.



Rotor core lined with the stator core and the shoulders on the shaft clears the bearings

Upon checking, the side toward which the rotor pulled was found to be a fraction low. This was corrected, but the rotor's action remained the same as before. Someone suggested that the motor pulley might not be in line with the driven pulley, and that the belt was responsible, but the rotor acted the same with the belt off.

It was finally determined that the laminations in the rotor did not line exactly with the laminations in the stator when the rotor was in central position between the bearings. A press was available, and after careful measurements the rotor was taken to the press and pressed over on the shaft until it would center with the stator. When reassembled, the rotor floated properly and operated as it should. M. A. DOUGLAS.

Cleveland, Ohio.

No More Plugged Piston Water Lines

WE HAVE overcome some operating difficulties on our Diesel dredge, and similar ones may have bothered operators of other engines.

This barge operated in shallow water and at times the cooling-water system became plugged. As the pistons are water-cooled, it was especially difficult to keep them from overheating. Because of the small diameter of the telescopic tubes, they would plug up very easily and the engines at times had to be shut down in order to clear the pipes.

As the temperatures of the piston-water discharge usually is carried about twenty degrees higher than the discharge water from the cylinder jackets, we figured that by letting the water go first through the cylinder jackets and then through the pistons, most of the sediment would settle in the cylinder jackets, where it could be drained off at regular intervals. We also put a duplex strainer between the cylinder discharge and the pistons, but seldom find it necessary to clean them.

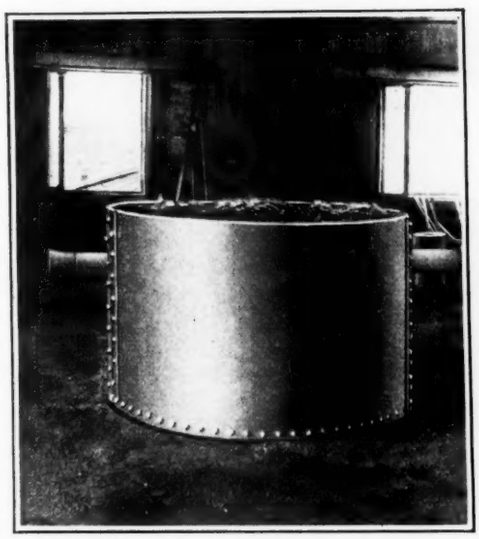
The change was made at little cost and has proved entirely satisfactory regarding both the temperatures of the piston discharge water and the elimination of the mud trouble. CHARLES T. ANDERSON,

New York City. Dredge "W. L. Marshall."

A Small Furnace for Heating Forgings or Preheating Castings for Welding

THE accompanying photograph shows how a furnace for heating small parts for forging or for preheating castings for welding can be made from a piece of an old discarded steam boiler. The tubes were removed from the boiler, and a section 2½ ft. long was cut from one end of the shell with an acetylene torch. A blowpipe is made from a piece of 3-in. pipe and connects with a mechanical blower. The blow line is led through the shell about six inches below the top edge and fitted with a tee in the center and a plug at the other end.

A filling of plain clay is put in the shell and tamped tight, covering the blow line. A short nipple is screwed in the side outlet of the tee and extends up to within two inches of the top. The remaining space in the shell is then filled with a good clay mortar in which a quantity of salt is used to harden it and make it firm. Before placing this filling, a piece of furnace grate was placed



Heating furnace cut from boiler shell

over the upper end of the nipple and the filling made over the edge of this. The grate prevents large pieces of coal or clinkers falling into the blow pipe and obstructing it. As small amounts of ashes and cinders will drop through the grate occasionally, a wooden stopper is inserted in the protruding end so the pipe can be blown clear or a rod inserted to remove the obstruction. A discarded gate valve is placed in the blow line between the blower and the forge, with which the blast is regulated or shut off when not needed. L. M. JORDAN.

Cairo, Ga.

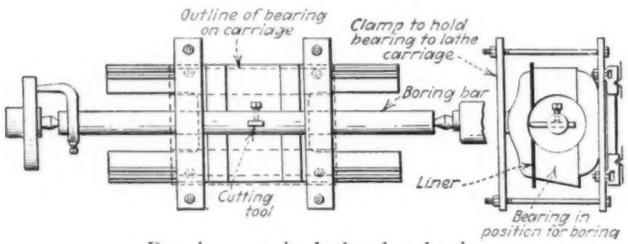
COMMENTS FROM READERS

In which those who agree and those who disagree, with either authors or editors, are afforded an opportunity to express their views

Pouring a Four-Piece Adjustable Bearing

REFERRING to the article in the March 6 issue by H. C. Cunningham, on "Pouring a Four-Piece Adjustable Bearing," it seems to me that it would have been better to have had the wood mandrel at least one-half inch smaller in diameter than the shaft and to have peened the babbitt thoroughly before boring the bearing to size. The accompanying sketch illustrates a simple method used for boring bearings of this kind.

Use an ordinary engine lathe, remove the tool post and compound rest, then take two flat iron bars, channel or I-beams, long enough to reach across the carriage and of



Bearing set in lathe for boring

sufficient height so that the bearing will be centered, and securely fasten them to the carriage. Then, if a boring bar is not available, take a piece of shafting of sufficient diameter and length and make one as shown in the illustration.

To set up the job, place the boring bar on the lathe centers, and fasten one end with a dog to the faceplate of the lathe. Next, place the bearing on the lathe carriage and center it with the boring bar, then securely clamp it in position. The best cutting speed will be readily found by trial.

If this method is followed, using genuine babbitt, the job will be first-class and the scraping, usually necessary to fit a bearing to a shaft, will be eliminated.

Being a manufacturer's service engineer, I have followed this procedure many times and have found it to be the best method of securing first-class workmanship in a minimum of time. B. M. ADAMS.

Hamilton, Ohio.

* * * *

Grouting vs. Bedding Machinery

I HAVE been much interested in the articles on "Grouting vs. Bedding Machinery" which have appeared recently in *Power*.

I have had considerable experience in erecting heavy machines such as turbines, generators, waterwheels, etc., and have encountered some severe vibration troubles due to excessive voiding in grouting. Some of these troubles have been remedied by grouting in the following way:

In setting up the heavy apparatus, set and wedge up in the usual way and erect a dam around the machine three inches or more away from the base and make it a minimum of one inch higher than the base of the machine. Wet down the foundation and pour the grout in the fluid state of mixture desired. (I usually use raw cement.) Pour in at several points until it is above the base. Provide two or three men with metal switches made from No. 4 copper wire and long enough to reach half way through the setting. Agitate the grout by inserting the wire switches under the base and keep pouring the grout until it is of sufficient height to take care of shrinkage, etc.

I have found this simple process to give good contact under the machine and to be practically free of voids or pockets. Be sure to agitate grout under the base thoroughly with the switches. In building foundations, care in having the surface of the same level is a great aid in setting and having a joint of uniform thickness. I prefer grouting to bedding, as grout poured in on a wet surface will bond better than a mixture tamped in.

Warrenville, S. C. J. P. MORAN.

* * * *

Straining a Boiler with Overpressure

IN HIS letter in the March 6 issue, entitled "Why Boilers Explode," J. S. Short asks if a boiler that was designed for 100 lb. pressure and owing to neglect was subjected to a pressure of 250 lb., would be stressed beyond a safe point. Also, if the elastic limit be not exceeded, was the boiler damaged?

To answer the first question, it is my opinion that the boiler was strained. By referring back to the article in the November issue, it is stated that new rivets were driven and the seams calked. This, however, would not necessarily mean that the boiler had been permanently damaged.

As to the second question, I believe that the boiler would have to exceed a great deal more than just the elastic limit to be damaged to any noticeable extent.

The general opinion that stressing a metal beyond its elastic limit injures it, has been proved to be untrue. It is not the mere stressing of a metal beyond its elastic limit that injures it, but the stressing many times repeatedly.

When this boiler was being built and was going through the bending rolls, one side was put in compression and the other was in tension. If the elastic limit had not been reached, the plate would straighten out when it was taken out. Stresses of as much as 7 to 15 tons per square inch may be obtained in it as it comes from the rolls, and unless the plates are annealed, these stresses will still exist after it has been built into the boiler. In such a case, however, when exposed to the additional stress due to the pressure inside the boiler, the overstrained portions of the plate will relieve themselves. After a short time there would be little difference in the strength of the plates after they had been rolled and one that had never been rolled.

Therefore, I believe that the boiler would be just about as good as ever after new rivets had been driven and the seams calked, if there were no signs of cracked plates and the plates had not been stretched enough so that the thickness had been materially reduced in any place.

Chattanooga, Tenn. JAMES M. LYLE.

Usual Method of Finding Piston Clearance Not Always Reliable

BUMPING point clearances of piston and cover of compressors and air pumps are often determined by inserting a piece of lead wire into the cylinder through some convenient opening when the piston is still some distance from the end of the stroke.

The piston is then moved to the end of the stroke and back a little way. The thickness of the squeezed lead wire is taken to indicate the clearance, but owing to some irregularity in the face of the piston and the surface of the cover, the thickness of the lead wire will not represent the minimum clearance. This is also the case when solder wire is used instead of lead. Solder wire is generally composed of equal parts of tin and lead and offers so much resistance to being squeezed that, especially with large pistons, deflection takes place.

There is only one sure way that I know of finding the bumping clearance, and that is to take out the crosshead pin and force the crosshead back until it is certain that the piston is in contact with the cover. Tram marks are now made which, when the crosshead pin is again in place and the crank placed on center, will indicate the actual clearance. Of course the same plan can be used for finding steam-cylinder bumping clearances.

Long Beach, Calif. E. J. JORDAN.

* * * *

Cleaning the Fire Side of Boiler Tubes

THE boilers in use on the cruisers and destroyers in the United States Navy are of the accelerated type where the tubes tend toward the vertical in inclination. The tubes are small, either bent or curved. These boilers are known as express boilers and are light in weight and in weight of water contained.

Soot from two to six inches in thickness is deposited in the tube nests over the lower drums, and as the tubes are small and nested close together, great difficulty is experienced in its removal. Blowing by steam or air has little or no effect. It is estimated that 90 per cent of tube failures occur at this point, owing to external corrosion.

In order to remove the soot and scale, it becomes necessary to take boilers out of service for long periods and resort to laborious hand cleaning.

The hydraulic method of cleaning the fire side of boiler tubes described by H. A. Seiller in the April 17 issue has been a success, having been in use more than a year. Engineer officers on the cruisers and destroyers are enthused with the successful results of this method.

The method, however, does not seem practical or necessary in stationary boilers, other than those of the small tube express type.

In boilers of the free circulation type such as the various makes of horizontal water tube, the tubes are large and not nested close together as in the express type. A good type of soot blower properly installed so as to sweep all the tubes will remove the soot deposits in this type of boiler. The great majority of power-plant boilers are equipped with blowers that do remove nearly all the deposit.

The arrangement aboard a destroyer is portable and operated by hand, using steam or air, and it is almost impossible to direct the jet in such places as in closely nested parts, and the results were as described in the second paragraph of this letter. EARLE S. NASON,

Boston, Mass. Chief Machinist, U. S. Navy.

Causes of Pulsations in Furnaces and Vibrations in Boilers

FOR several months letters from readers have appeared in *Power* regarding droning, vibrations and pulsations in furnaces and boilers. The opinions as to the cause of this phenomenon varied. This is to be expected, as the causes of such troubles differ. The remedy in one case is not applicable to another.

Pulsation in furnaces is the throbbing or panting of flames of combustion. The repetition by reflection of sounds and pressure differences from the non-elastic walls, sets up a reverberation. The creation of sympathetic vibrations or oscillations is secondary to the primary producing agency. Both the vibrations and accompanying throbs, detonations or droning sounds are always in perfect unison with the fundamental pulsation, its tone or one of its harmonics—simply a resonant echo. Pulsations are harmless and in some cases of great advantage,[1] up to a point of creating impulses sufficiently great to distort the equilibrium of combustion. When they induce serious reactionary vibrations, which damage furnace walls and baffles, shake the boilers and piping, an extremely hazardous condition exists.

Pulsations can occur in the burning of coal or oil. They are most pronounced in natural-draft mechanical-atomizing fuel-oil burning. Boilers of this type, working at high ratings, using either forced or induced draft, will, under certain conditions, vibrate seriously. In warming up coal-fired boilers, vibrations are sometimes troublesome. Gas furnaces are remarkably free from pulsation difficulties.

Physical experiments with flames show that: (1) Different sounds will be sonorously retained in flames under varying conditions; (2) the bunsen flame at certain adjustments will repeat and hold different harmonic notes, projected into them from the tuning fork; (3) the seat of the sensitiveness is at the root or where it leaves the tip; (4) naked flames, as well as those surrounded by resonant walls, always pulsate exactly in synchronism with the audible beats; (5) even the silent candle flame, while immune to high-power sonorous sounds, will show an incipient flutter when a narrow stream of air is urged through it. The flame will jump visibly now if a whistle is sounded. It seems flames are not affected much by sound until air is urged through them. Flames can, however, be shortened and caused to split into tongues by projecting sounds at the root. Apparently, this phenomenon is analogous to the nodule formations in sound vibration experiments.

The definite control of pulsations entails a thorough study in each case. The primary factor is—changes in furnace temperature alter the amount of liberated heat energy and in consequence vary the furnace gas volume. Combustion is like all chemical reaction and follows the laws of mass action and chemical equilibrium. It is influenced by the temperature of the reaction masses, by mixing of the combustible and by dilution of inert gases, the velocity reaction increasing rapidly with any increase in temperature.

In fuel-oil burning furnaces pulsations and vibrations are most frequent and violent. The contributory factors in such cases, which provoke variable heat release and cause pulsation propagation resulting in vibrations,

[1] In burning pulverized coal, pulsations augment turbulence and help to sweep off the films of CO_2 gas from the coal particles. This helps to shorten the flame travel and speeds up combustion.

may be itemized as follows: (1) Variation in percentage of air to oil; (2) unsteady or incorrect oil temperature or pressure, and any abrupt change in either; (3) unbalancing of perfect burning air-oil admixture; (4) reactionary effect of unstable gas velocity; (5) duration, intensity and cycle period of pulsations; (6) effect of furnace volume and design.

It is important that any comparative investigation studies made, must take into account parallel conditions as to atmospheric humidity, temperature and pressure, as well as B.t.u. content of fuel.

The following notations are the result of investigations I made in overcoming serious pulsation difficulties.

The incandescent fuel bed, flames of burning volatile gases, and smoke of prematurely condensed burnable gases are manifestations of combustion. The relative intensity of each is directly influenced by physical nature and chemical content of fuel; methods of air and fuel admixture and delivery, and quantity of fuel consumed to furnace size and design.

Atomization of fuel accelerates combustion, regardless of the kind of fuel being burned. Flame propagation directly depends on the amount of volatile gases, speed and intimacy of contact of the air and fuel. Extremely fine atomization and correct air supply expedite combustion reaction. Smooth non-pulsating combustion pivots upon the constancy of a chemical reaction-equation, which maintains a perfect balance for all ratings of furnace operation.

Some Causes of Pulsations

1. Any change in amount of air supply per pound of fuel or any unreasonable air temperature difference will vary the combustion rate. Also, in certain furnaces it will swell the panting beyond the capacity of the furnace volume. Changing furnace pressure reacts on air-velocity delivery. This affects the amount of air delivered, and any improper diffusion of the entering air further aggravates matters. In natural draft this is particularly bad, as combustion momentarily slows down, permitting a slippage of air around the flame. It is possible for this air to burn later and set up a secondary combustion. Incidentally, periodic back pressures occur, a reaction on the discharging furnace gas velocity ensues.

2. Oil must be preheated to suit the corresponding oil pressure and size of tip. Changing boiler ratings require different oil pressures; oil temperature must be altered to suit the particular pressure. Abrupt changes in temperature or pressure cause a retarding or advancing reaction of combustion. The abruptness of change affects the pneumatical balance and upsets the inertia of the gas flow—thus pulsations are started.

3. The rate of combustion will remain uniform and resulting gas flow steady, until compelled to do otherwise from some external change. Mixing of the air has a pronounced effect on the velocity of reaction. When flames mushroom, a curtain fire of burning gases rising through stagnant parts of the furnace atmosphere, causes a series of connection currents, permitting every particle of the gases to be thoroughly intermingled. When the flame is so held for the proper period, perfect uniform combustion is obtained with no vibration difficulty.

Wind pressure affects the stack draft appreciably. Variations in wind direction and velocity deflections due to surrounding structures, down drafts, etc., are sometimes reacting on the air entering the furnace. Intermittent vibrations are sometimes caused thereby. With natural draft it is difficult at times to compensate for such changes, on account of the close balance of draft and gas-flow resistance.

5. The final physical results of the recurrent disturbing forces which produce pulsations depend on the magnitude of the primary disturbing force and its mass. The impulses, or blows, must have a certain size and time period, to create a resonance of the right frequency and amplitude to be discernable as a vibration of the furnace or boiler.

6. As explained in 5, pulsations occur at low boiler ratings; at such times furnace volume is proportionately great to quantity of fuel burned; vibration trouble, however, is not materially manifested. When similar intensity panting exists at high boiler ratings, vibration of the boilers and piping is serious.

When vibrations are once set up, dampening out must be resorted to, and in each case different tactics must be applied.

Ways of Stopping the Vibrations

On a set of natural-draft oil-fired vertical water-tube boilers, it was noticed when a stable atmosphere existed and stack gases ascended vertically, there was a cessation of vibrations. At other times, putting out a burner would suffice. When combustion was uniform again, the burner could be relighted. Changing the size of the air impeller plates and examining burner tips overcame the difficulty. A set of oil-fired natural-draft horizontal water-tube boilers would vibrate when the registers were left wide open and pulsations started; opening the damper wide and thoroughly sweeping out the furnace would check the vibrations. (In regenerative furnaces at times of reversal, a strong draft is likewise applied, to sweep out the furnaces thoroughly to prevent explosions.) Larger impeller plates were installed and the registers closed as much as possible. Draft was controlled by the adjustment of the stack damper and vibrations were then entirely absent. However, a sudden change in the oil temperature or pressure would again start vibrations, and when started, they could be immediately checked by further closing the registers. This increased the air velocity at the root of the flame, dampened out any pulsations and stabilized conditions. At another plant of horizontal water-tube boilers, when operated at low ratings and natural draft, serious vibrations existed. Running the forced-draft fans slowly overcame the difficulty. On another set of horizontal water-tube boilers calking the cleaning doors and preventing air leakage above the furnace, stopped the vibration difficulty.

Three other instances of vibration difficulties were overcome by simple means. In one case cessation was effected by the removal of the perforated plates on the inside of the boiler doors. Vibrations occurred in a coal-burning plant, when warming up cold boilers. This difficulty was overcome by placing wire screens over the ash screen doors. These screens prevented the backfire action, creating pulses that set up vibration of the boilers. In another case of forcing mechanical oil-atomizing furnaces equipped with forced draft, vibrations which shook the doors and upstakes was caused by overheating the oil and excessive oil pressure. This was done in an attempt to stop smoke from the overworked furnace. By changing the tips and readjustment of the cones, the pressure could be reduced and a less oil temperature carried, and vibrations entirely ceased.

San Francisco, Calif. J. M. Brennan.

PLANT EQUIPMENT NEWS

New and improved equipment in power and industrial plant fields, and new applications of existing equipment

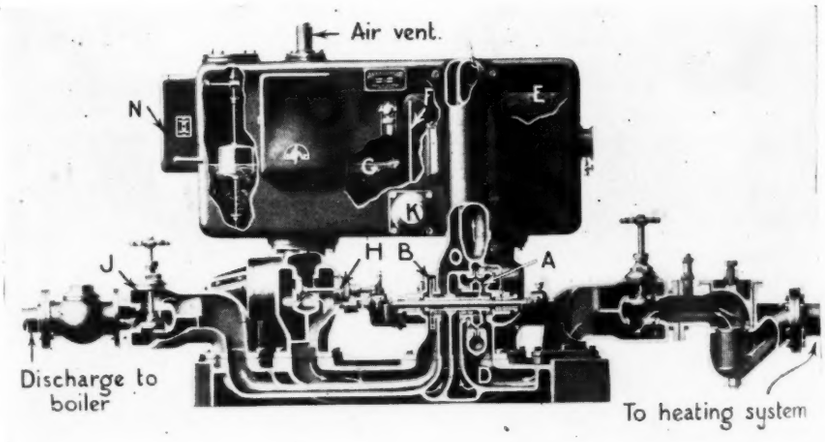


Fig. 1—Sectional and cut-away view of duplex pump assembly

Ames Return-Line Vacuum and Boiler-Feed Unit

SIMPLICITY and accessibility, with compactness of design, are features of the combined return-line vacuum and boiler-feed unit in single and duplex types, brought out recently by the Ames Pump Company, Inc., Division of the Staten Island Shipbuilding Company, 90 West St., New York City.

The unit is designed for use with heating systems that require a 5- to 10-in. vacuum, or a fixed vacuum differential, where a vacuum of 20 to 25 in. is carried.

Referring to Fig. 1, which shows a cut-away view of the duplex pump assembly, the unit consists essentially of a combined motor-driven condensate and vacuum pump with separate boiler-feed impeller on one shaft and a two-compartment receiver with automatic control, mounted on a box-type base in which are embodied the interconnecting channels between the receiver and pump and the inlet and outlet connections.

The pump is of the multi-rotor centrifugal type, with a vacuum-producing element *A* (see Fig. 2) and boiler-feed impeller *B* running in separate chambers. The element *A* consists of an impeller combined with a centrifugal Venturi ejector nozzle at its periphery, with diffuser plates *C* inserted in the pump casing. The impeller is supplied with injection or hurling water from the receiver, and this, in passing through the nozzle of the impeller, produces a vacuum in the suction chamber *D*, causing the condensate and air to be drawn from the system and discharged with the hurling water to the top of the

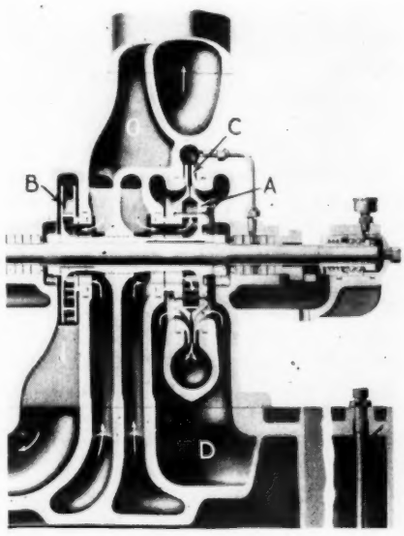


Fig. 2—Sectional view of combined return-line-vacuum and boiler-feed pump

compartment *E* of the receiver. From this compartment the condensate flows over the baffle *F* to the compartment *G*, and the air is vented to the atmosphere.

From the compartment *G* of the receiver the water flows through the valve *H* and connecting channels, as indicated by the arrows, to the boiler-feed impeller *B* by which it is discharged through the valve *J* to the boiler. The smaller compartment *E* of the receiver serves to maintain a fixed head and supply of hurling water for the impeller *A*, while the compartment *G* provides a storage for the condensate or boiler feed. The compartments are interconnected by means of the valve *K*.

The pump is fitted with stationary

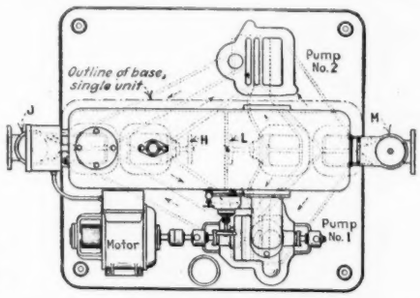


Fig. 3—Plan of duplex unit, showing interconnecting channels between receiver and pump

labyrinth sealing rings of the single deep-groove type. The shaft, which is of non-corrosive steel, is carried on double-groove ball bearings mounted in brackets cast intergral with the lower half of the pump casing. The stuffing boxes are of liberal depth and are filled with metallic packing, with a thin metal plate between rings. The glands are split and are adjusted by swing bolts. All internal parts of the pump, such as impellers, sealing rings, distance sleeves, packing glands, distributing valves, etc., are of Government bronze, and the injector nozzle and diffuser plates are of gun metal. The motor and pump are direct-connected through an all-metal lubricated flexible coupling of special design having floating space to compensate for expansion due to varying temperatures of condensate.

Fig. 3 shows a plan of the pump, with the water passages in the tank supporting legs, and in the base, indicated by dotted lines. The control valves *H*, *J*, *L* and *M* serve to direct the flow to either No. 1 or No. 2 pump in the duplex unit. The flow

of the single unit is identical with that of the duplex, with the exception that single- instead of multi-ported control valves are used.

The unit is automatically controlled by a vacuum regulator and float switch *N* mounted on the receiver. Vapor binding of the boiler-feed impeller *B* is obviated by reason of the manifold passage *O* leading to the top of the compartment *E* of the receiver.

Units in single and duplex types are available in capacities suitable for 12,000 to 150,000 sq.ft. of radiation.

Hand Extinguisher Operates With Air Pressure

DEVELOPMENT of the one-gallon F-R-X carbon-tetrachloride fire extinguisher illustrated, which operates from an air-pressure tank, has been announced by the Foamite Childs Corporation, Utica, N. Y. This unit consists of two seamless cylindrical brass tanks, one for compressed air and the other for the chemical, fitted into top and bottom brass frame castings. A pump is located between the cylinders to replenish the air pressure, or the cylinder may be filled from a compressed-air line.

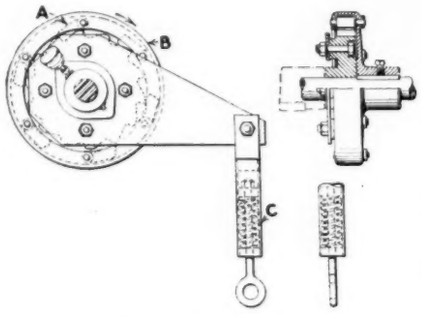
Air operated fire extinguisher

The flexible chemical outlet tube is constructed of spiral-wound bronze reinforced with a braided copper wire covering. The extinguisher is equipped with a gage that shows the air pressure at all times, and a glass window near the top of the chemical chamber shows whether the extinguisher contains a full gallon of chemical.

The unit is discharged by pulling up the operating lever which releases the air pressure into the chemical cylinder and also opens the outlet. The extinguisher is especially adapted for use around electrical equipment, on oil fires, and in unheated buildings.

Ratchet Safety Lock for Elevators and Conveyors

FOR large elevators, pivoted-bucket carriers, belt conveyors and similar equipment, where the load on the vertical lift would cause a backward run of the equipment with interruption of power, the Jeffrey Manufacturing Company, Columbus, Ohio, has developed a silent ratchet safety lock. The lock provides protection against spilling a loaded elevator or inclined elevator where an unexpected interruption of power occurs.



Ratchet safety lock with ratchet A engaged

The illustration shows how one of the six pawls grouped around the ratchet is always in position to grip a ratchet tooth, the pawl *A* being shown engaged. The housing *B* is bolted to the countershaft and turns with it when the power is on. The pawls are spaced around the ratchet teeth so that the maximum backward motion of the ratchet is no more than one-third of the distance between the teeth, being less than one inch on the largest elevator.

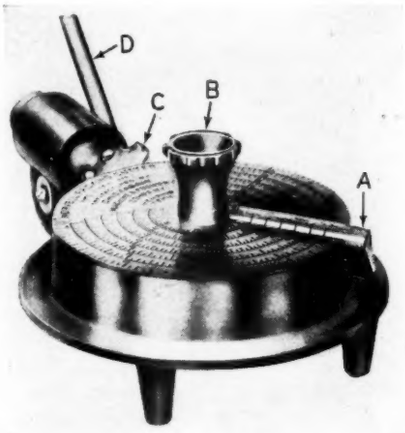
Another feature of the safety lock is the spring attachment *C* which absorbs the shock. This spring acts as a snubber on the arm bolted to the ratchet and when the load descends on the pawls the spiral spring takes most of the force of the blow.

The ratchet safety lock can be fitted on elevators and inclined conveyors now in use as well as on new installations.

Norvell Packing Cutter

THE illustration shows the Norvell packing cutter recently brought out by the Chickasaw Machine & Foundry Company, Memphis, Tenn.

The cutter is designed to cut piston and valve-stem packing of any size



Cutter for packing up to 1-in. to fit any size rod up to 7-in. diameter

from ¼- to 1-in. to fit any size stem or rod from ½ to 7 in. in diameter. The dial on the cutter is graduated to give the correct length for any size packing and any size rod within its range.

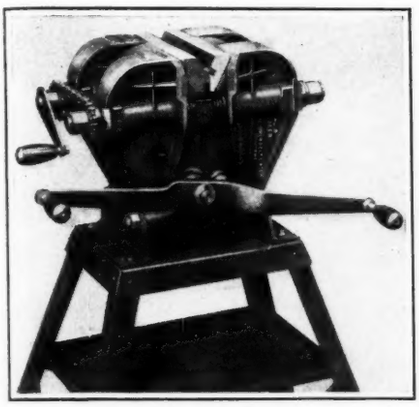
To use the machine, the stop *A* is moved to the proper graduation on the dial and tightened by the thumbnut *B*. The end of the packing is first cut with the knife *C* to give it the proper bevel. Then that end is laid against the stop *A* and held in place with one hand while the knife *C* is moved forward with the lever *D*. This cuts the ring the proper length and the correct angle to give a good joint.

The knife *C* is made of saw steel and is actuated by a rack and pinion with teeth cut from solid steel. The body of the cutter is of gray iron and the dial is of etched brass.

Clipper Belt Lacer No. 8

THE No. 8 belt lacer brought out by the Clipper Belt Lacer Company, Grand Rapids, Mich., is designed to lace one end of a belt, in any width up to 8 in., in one operation. The Clipper belt hooks are spaced in position by the spacer bar inserted in grooves in the jaws of the machine. The end of the belt is placed in the open hooks against the bar and the jaws are then forced to-

gether by a turn of the crank on the front of the machine. Adjustment of the jaws for the various sizes of belt is made by the crank on the left-hand side of the machine, shown in the illustration. The force exerted by the jaws puts the hooks into the



No. 8 Belt Lacer

belt evenly and embeds them flush with the surface.

It is claimed by the manufacturer that both ends of an 8-in. belt can be laced in less than two minutes.

The machine may be bolted to a workbench or furnished with a stand, as shown in the illustration.

A. B. See Has Vertical Traction Elevator Machine

FOR installations where the space is limited, the A. B. See Electric Elevator Company, Inc., New York City, has designed a vertical single-wrap traction-type elevator machine. In order to obtain small over-all dimensions, the driving motor has been placed in a vertical position and the brake placed above the outboard bearing of the motor instead of between the motor and worm-gear housing as in general practice. This machine is for capacities up to 1,000 lb. at 100 ft. per min. and occupies a floor space of 24½ by 19½ in. by 36 in. high.

The base of the machine, which is also the lower half of the worm-gear housing, is provided with two feet under the end carrying the driving sheave and with one under the motor end, as shown in Figs. 1 and 2. This gives a three-point support and insures that the alignment of the various parts comprising the complete machine will remain permanently as originally made in the factory.

A box-type worm-gear housing is used, which is webbed for strength and stiffness. It contains two babbitt bearings for the driving shaft and the supports for two specially designed anti-friction bearings which carry the worm shaft. The latter bearings are also designed to take care of the worm-shaft thrust in both directions, means being provided for their accurate adjustment.

An extra large diameter driving-sheave shaft is used and carries the worm gear between its bearings in the housing. The driving sheave is mounted on an extension of this shaft,

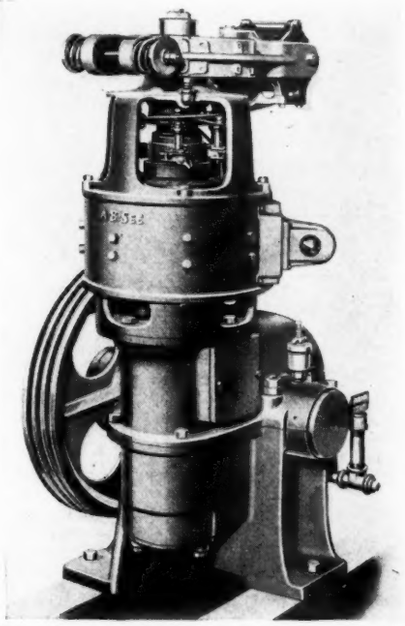


Fig. 1—Machine equipped with a direct-current motor

which projects through the bearing on the side away from the worm gear. This position of the driving sheave allows the machine to be placed either over the hoistway or in the basement without change in its design.

The worm and shaft is cut from a steel forging and is ground to exact size. A phosphor-bronze worm wheel is used, the teeth of which are machine-cut in continuous gear hobbers.

The upper end of the worm shaft extends through the bearings in the gear housing and serves to carry the rotor or armature of the motor and also the brake drum. The upper bearing of the worm shaft in the gear case serves as the lower bearing of the motor. The other bearing of the motor is in the end shield and is of the ball type. On the extended worm shaft immediately above this bearing the brake drum is mounted.

A housing for the brake is cast integral with the end shield of the motor and serves to hold in position the brake magnets, which are immersed in oil when alternating current is used. Pressure of the shoes on the brake drum is obtained by adjustable compression springs and is released by electromagnets when the motor is connected to the line. This is done in such a manner that, should the current be interrupted in any manner, the brake will be quickly applied and bring the machine to rest. The brake magnets are immersed in a tank containing oil, and means are provided by which the action of the magnets may be adjusted to give a smooth application of the brake and render it silent in operation.

Either a direct- or alternating-current type driving motor may be used, which is designed expressly for elevator duty. Quiet running of the motor is given particular attention, all motors being subjected on com-

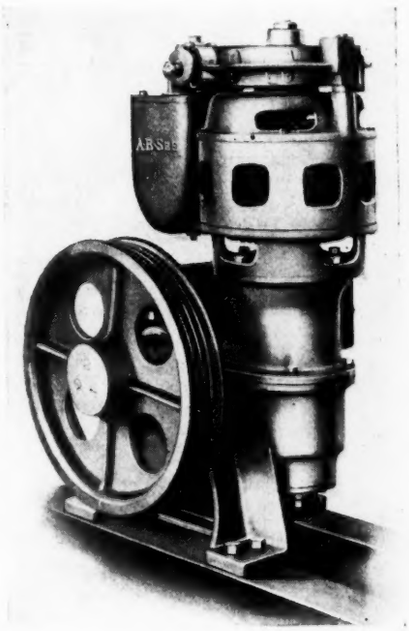


Fig. 2—Machine equipped with an alternating-current motor

pletion to a noise test in which the requirements have been set unusually high.

Lubrication of the worm and gear is secured by making the gear housing oiltight and filling it with oil to a level indicated for best operation. This insures that the gearing will be running in an oil bath. Lubrication of all other parts is by pressure grease cups except the top ball bearing of the motor, which is arranged for oil lubrication.

Industrial Pittsburgh is Background for A.S.M.E. Spring Meeting

THE award of welding prizes totaling $17,500 was a feature of the A.S.M.E. Spring Meeting, held at the William Penn Hotel, Pittsburgh, May 14 to 17. Papers dealing with steel manufacturing problems, education, high steam pressures, and power-station economics were included in the program. The numerous inspection trips to Pittsburgh industries included visits to plants of the U. S. Steel Corporation, Westinghouse Electric & Manufacturing Company, American Window Glass Company, Allegheny County Steam Heating Company, Blaw Knox Company, Duquesne Light Company, Mesta Machine Company, National Tube Company, R. D. Nuttall Company, Pittsburgh Piping & Equipment Company, Pittsburgh Testing Laboratory, and Pittsburgh Valve, Foundry & Construction Company.

The Lincoln Arc-Welding Prize, donated by the Lincoln Electric Company, of Cleveland, Ohio, and presented through the American Society of Mechanical Engineers, was won by James W. Owen, director of welding, Newport News Shipbuilding & Drydock Company, Newport News, Va. The prize of $10,000 was presented by Alex Dow, president of the A.S.M.E., and L. P. Alford, chairman of the Committee of Judges. It was awarded for the excellence of a treatise on arc-welding design, shop practice, and analysis of its industrial application and world-wide possibilities.

Two other prizes were presented, one to Prof. Henri Dustin, of the University of Brussels, Belgium, and the other to Commander H. E. Russell, of the United States Naval Academy at Annapolis. Professor Dustin won $5,000 for his paper on fundamental principles of arc welding, and Commander Russell won $2,500 for his paper on electric welding in ship bulkheads and similar structures.

Industrial Power

In the Tuesday afternoon session on Fuels, Iron and Steel, and Industrial Power, F. G. Cutler, Chief of Bureau of Steam Engineering, Tennessee Coal, Iron & Railroad Company, reported the results of several years' experience in combination firing of blast-furnace gas and pulverized coal at the Ensley blast-furnace plant. The results obtained were so satisfactory that the same general method of regulation of gas fuel and the storage system of powdered-coal firing, with separate coal-pulverizing plant, is now being installed at the new Fairfield blast-furnace plant of the Tennessee Company.

"Prior to 1922 some of the boilers at the Ensley plant were fired by blast-furnace gas, some by coal burned on hand-fired grates and a few by stokers.

"Steam conditions were unsatisfactory. Some of the older blast-furnace boilers were in such condition that it was expected that they would be condemned, and their combustion capacity was insufficient for the proper burning of the blast-furnace gas available most of the time.

"Six new Stirling boilers, 8,340 sq.ft. each, were installed with provisions to burn both pulverized coal and blast-furnace gas. The pulverizing plant was 500 ft. from the boiler house. Two more combination fired boilers of the same design were installed in 1925.

"These were arranged to be fired with either blast-furnace gas or pulverized coal, or a combination of both fuels at the same time. They were also equipped with gas-regulating equipment which operates to open the gas and interconnected air dampers whenever the gas pressure on the mains increases, and to close whenever the pressure falls.

"About 20 kw.-hr. per ton is required to pulverize and deliver coal to the bins at the boilers and about 1,200 cu.ft. of byproduct gas to dry the coal. The coal is dried from 7 or 8 per cent moisture as received to about one-half per cent. No trouble has been experienced in pumping the coal through the 625 ft. line.

"Indirect heat-balance tests have been made from time to time, and the efficiency indicated is usually between 72 and 79 per cent, depending on the rating. Tests made with pulverized coal alone show about 225 per cent of rating on capacity tests and about 79 per cent efficiency at 179 per cent rating. Both fuels are usually burned together, the ratio depending on gas and steam conditions.

"By this installation and the installation of a motor on the rail-mill rolls, it has been possible to shut down the boilers at the blooming mills and materially improve steam conditions, both as to pressure and cost of operation.

"Operating costs at the blast-furnace boiler plant for fuel, as well as for producing labor and for repairs and maintenance, are lower than before."

Welding prizes totaling $17,500 awarded. Steel manufacturing problems, high steam pressures and power station economics among the subjects discussed.

A new and ingenious design for a long distance recording water-level gage was described by E. B. Strowger, assistant hydraulic engineer, Niagara Falls Power Company, at the hydraulic session on Tuesday morning.

In a session on education on Tuesday afternoon, Prof. A. C. Jewett, of the Carnegie Institute of Technology, and F. L. Bishop, secretary of the Society for the Promotion of Engineering Education, presented papers on industrial and engineering education.

At the dinner on Wednesday evening the Holley Medal was presented to Elmer A. Sperry, noted inventor. George S. Davidson, past-president of A.S.C.E. and Engineers Society of Western Pennsylvania was toastmaster, and Charles M. Schwab was one of the speakers.

Officers Nominated

Officers nominated for the coming year are: For president, Elmer A. Sperry, chairman board of directors, Sperry Gyroscope Company, Brooklyn, N. Y.; vice-presidents, William Elmer, special engineer, Pennsylvania Railway

Company, Philadelphia, Pa.; R. L. Daugherty, professor of mechanical and hydraulic engineering, California Institute of Technology; and C. E. Gorton, chairman, Uniform Boiler Law Society, New York City; managers, Charles M. Allen, professor of hydraulic engineering, Worcester Polytechnic Institute, Worcester, Mass.; Ely C. Hutchinson, president, Pelton Water Wheel Company, San Francisco, Calif.; Robert M. Gates, manager, industrial division, Superheater Company, New York City; delegates to American Engineering Council, Elmer A. Sperry, chairman; E. O. Eastwood, Dean E. Foster, W. P. Hunt, O. P. Hood, Charles Penrose, Frank A. Scott, Max Toltz, E. N. Trump and D. Robert Yarnall.

Papers at the Central Station Power session on Thursday morning dealt with economic aspects of power generation and high-pressure steam boilers. Abstracts of papers and discussions follow.

Some Economic Factors in
Power Station Design

By H. Boyd Brydon

Mechanical Engineer, Byllesby Engineering & Management Corporation, Chicago, Ill.

THE last few years have afforded repeated instances of the tremendous efforts by those charged with the design of power stations to effect reductions in heat consumption. These have reduced the heat required to generate a kilowatt-hour, but to what extent has this accomplishment really been justified from an economic point of view?

By setting high enough the assumed capacity factor at which a proposed plant will operate, justification for increased expenditures to reduce heat consumption may easily be had. It is simply a question of getting the answer first. There is a tendency to overestimate the capacity factor. With rapidly growing maximum demands and with continuous improvement in the economy of units and of the complete plant layout, any given unit rapidly approaches a period of considerably reduced load factor, when newer units come into service and receive a disproportionately large share of the total load.

For any new installation the selection of equipment and operating conditions of pressure, temperature, etc., must be governed by the condition that over its effective life the unit should be capable of delivering to the distributing system the greatest quantity of salable energy per dollar of total cost.

Fixed Charges

Under given conditions of load and operating ability reduction of operating cost can be achieved only by increase of fixed charges. If the proposed increase in fixed charges is merely equaled by the estimated reduction in operating cost, obviously nothing has been gained. On the contrary, much has probably been lost, for the fixed charges go on whether the plant operates or not. From the date that installation of additional plant capacity is decided upon, capital expenditures are made. Taxes follow immediately upon the heels of capital expenditure. Insurance must be carried. As soon as the unit is placed in commercial operation, a depreciation fund must be set up.

The author assumes that all these items aggregate 13½ per cent per year, for an effective life of just under sixteen years.

Capacity Factor

Since these fixed charges are not infrequently greater than the production costs, it is clear that the importance can hardly be overstated of estimating as accurately as possible the degree to which use of the proposed capacity will be made throughout its effective life. The author presents evidence from various studies made under the auspices of the National Electric Light Association and the Association of Edison Illuminating Companies, indicating that for units whose records are available, the maximum capacity factor is about 60 per cent, that the average annual capacity for the first nine years is about 48 per cent and that if 30 per cent be taken as the factor for the remaining seven years of a sixteen-year effective life, the average capacity factor for the whole sixteen years is about 40 per cent.

After laying down some fundamental principles in power-station design, the author outlines briefly a series of studies of the design of a proposed new power house at Brunot Island, Pittsburgh, Pa. His conclusion that a steam pressure of 400 lb. is preferable to 600 or 1,200 will interest many engineers.

It is of considerable interest to note from the data presented that the number of units reported upon falls rapidly after about six or seven years, indicating that units older than this are not in regular daily operation.

Operated-Hours Factor

A 40 per cent capacity factor does not mean that the machine will operate at capacity for 40 per cent of the year and be shut down for the rest of the time. Average loads range from 60 to 70 per cent, with a corresponding operated hour factor from 44 to 70.

An Actual Design Study

Following this discussion the author summarizes an investigation to determine the design of a proposed power house at Brunot Island. The following factors are assumed: 1. Effective life, 16 years; 2. Capacity factor, 40 per cent; 3. Operated-hours factor, 70 per cent; 4. It was further decided to use a standard type of unit, tentatively a 60,000-kw., 80 per cent power factor, single-shaft machine.

These assumptions led to an average annual generated output of the unit over its effective life of sixteen years of about 210,000,000 kw.-hr. From tentative estimates of auxiliary power the corresponding average annual salable output would be about 200,000,000 kw.-hr. for a 400- or 600-lb. plant, and about 195,000,000 kw.-hr. for a 1,200-lb. plant.

TABLE 1—NET HEAT CHARGEABLE

Steam Conditions	Heat per Kw.-Hr., B.t.u.	Heat Saving, Per Cent
400	10,990	.....
600 (a)	10,710	1.54
600 (b)	10,450	4.93
600 (c)	10,140	7.76
1,200 (a)	9,790	10.90
1,200 (b)	9,530	13.3
1,200 (c)	9,475	13.8

It should be noted that these savings are for the turbine only; they do not represent the relative economies of stations operated on several steam cycles.

Thermodynamic efficiency is limited by the pressure and temperature available or permissible. Water temperatures at Brunot Island limit the absolute exhaust pressure to one inch of mercury. Commercially available metal limits the steam temperature to 725 deg. F.

Studies were made for three operating pressures.

For the 400-lb. plant the steam cycle is taken as straight regenerative.

For the 600-lb. plant three plans were considered: (a) Straight regenerative; (b) with steam reheat added to (a); (c) with boiler reheat added to (b).

For the 1,200-lb. plant regenerative steam heating was considered with three methods of reheat: (a) One-stage steam reheat; (b) two-stage steam reheat; (c) two-stage steam reheat and one-stage boiler reheat.

TABLE II—TOTAL OPERATING COST

400-lb. Plant:	
Fixed charges	$896,800
Coal	243,338
Labor	153,000
Maintenance	50,000
	$1,343,138
600-lb. Plant (a):	
Fixed charges	$943,100
Coal	236,250
Labor	153,000
Maintenance	60,000
	$1,392,350
600-lb. Plant (b):	
Fixed charges	$946,755
Coal	231,525
Labor	153,000
Maintenance	60,000
	$1,391,280
600-lb. Plant (c):	
Fixed charges	$968,490
Coal	224,685
Labor	153,000
Maintenance	65,000
	$1,411,175
1,200-lb. Plant (a):	
Fixed charges	$1,253,340
Coal	216,877
Labor	153,000
Maintenance	80,000
	$1,703,217
1,200-lb. Plant (b):	
Fixed charges	$1,259,820
Coal	210,982
Labor	153,000
Maintenance	80,000
	$1,703,802
1,200-lb. Plant (c):	
Fixed charges	$1,352,160
Coal	210,026
Labor	153,000
Maintenance	90,000
	$1,805,186

Information from the manufacturers gave the net heat chargeable under each condition, shown in Table I, average load of 42,000 kw.

Cost of Plant

The author shows preliminary general-arrangement drawings of the several types of plant considered. On the basis of these layouts he estimates first cost. For the several conditions the costs are not even approximately identical, varying from $6,642,000 to $10,016,400.

These estimates cover buildings adequate for two units, with one unit installed at present. They do not include electrical equipment, transmission lines and similar items, nor legal expense, cost of land, railroad connections, etc.

Several items must be considered in estimating the operating cost of stations, among them, cost of auxiliary power, method of auxiliary drive and effect of pressure on boiler economy.

The author discusses briefly several methods of charging auxiliary power, favoring charging this power at the total cost of production including that portion of the fixed charges that may fairly be allocated to the auxiliary equipment.

Drive for Auxiliary Equipment

The means adopted for driving the auxiliary equipment must insure starting the station in the event of a system shutdown, and offer the greatest security to continuity of operation. The following methods for auxiliary drive can be used singly or in combination:

1. All-steam drive at station steam pressure and temperature.
2. All-electric drive from the station busbars.
3. All-electric drive from auxiliary generators, direct driven by the main turbines.
4. All-electric drive from auxiliary turbines driving house generators.

Given sufficient money, it is not difficult to reduce heat consumption. The question is, Will it pay—in dollars? Are not the dollars spent for capital charges increasing faster than the dollars saved by reduced coal consumption?

5. All-electric drive through motor-generators supplied from distribution system.
6. All-steam drive from a self-contained auxiliary station having its own boilers.

Subject to the economic requirements, the first method of drive can be used certainly for 400-lb. and probably for 600-lb. For the 1,200-lb. station, the cost of the auxiliary turbines and their piping appears to be prohibitive.

The second method is objectionable because of the high cost of transformers and of switch gear.

The use of auxiliary generators driven by the main turbine (method No. 3) is bad from the operating standpoint because trouble on a main unit requiring shutting it down would also shut down the auxiliaries.

The house turbine system (No. 4) has worked out well for moderate pressures but for 1,200-lb. work would be costly and might involve an undesirable degree of risk to continuity of operation.

Given adequate supply by a number of different routes for the cables, the system of driving the station auxiliaries through motor generators (No. 5) offers a means of escape from the principal objections to methods Nos. 2 and 3.

Probably the safest, though not necessarily the least costly, system is that of providing a complete and separate auxiliary station supplying steam to the main-station auxiliaries from its own boilers, operating at a pressure permitting the use of moderate-priced turbines for the auxiliary drive (method No. 6).

Effect of Pressure on Boiler Efficiency

The higher temperature of saturated steam at higher pressures affects the temperature to which the flue gas can be cooled, and thereby changes slightly the boiler efficiency. For the purpose of this study the author has assumed a boiler efficiency of 86 per cent for all pressures.

Heat Consumption of Plant

For these preliminary estimates, the assumption is made for all plants that the heat consumption of the station per generated kilowatt-hour will be 5 per cent greater than the net heat chargeable to the turbine as given in Table I. This figure is divided by the station output and by the boiler efficiency to obtain the station heat consumption.

Operating and maintenance labor has been estimated for the first unit as 71 men at an average wage of $150 per month. This gives a cost of $153,000 per year, which is taken to be the same for all cases.

Sufficient experience with 1,200-lb. plants is not available for determining a proper maintenance cost. The figures given in Table II are considered fair.

Table II summarizes the estimates of total operating costs for the several conditions. as shown.

Conclusion

It is considered that the adoption of 400-lb. pressure has been shown to be preferable on the score of simplicity, ease of operation and cost. Should conditions ever arise under which the use of a pressure of 1,200 or 1,500 lb. may become attractive, the proposed pressure will fit in nicely. The 600-lb. plant will not.

Discussion of Brydon Paper

In discussing Mr. Brydon's paper on power-station economics, John Anderson, of Milwaukee, pointed out that the low price of coal assumed by Mr. Brydon limits the applicability of his conclusions. He also contended that the high-pressure plants considered are needlessly expensive. The 1,300-lb. plant at Lakeside, on Mr. Brydon's basis, costs only 6.3 per cent more than the equivalent 300-lb. plant.

Mr. Anderson held that the reheating arrangements should be much simpler. There is no need, he said, for large spare capacity in high-pressure boilers. High-pressure maintenance costs are no higher than low, and ample experience supports this contention.

Mr. Anderson took exception to the temperatures presented by Mr. Brydon in computation. High-pressure plants, he said, are distinguished for unusual ease in operation.

High-Pressure Steam Boilers

By George A. Orrok

Consulting Engineer, the New York Edison Co.

DESPITE extensive discussion of the subject by eminent engineers and the successful development of high-pressure boilers along the lines of standard types, the author feels that nobody has laid down basic principles or indicated the general trend that successful design and construction should follow. This paper is an attempt to bring the problem nearer to solution by suggesting the lines which, to the author, appear to offer the most promise.

Credit is due to Ernest Albans whose work, about 1840, forecast the principles upon which high-pressure boilers should be designed. He recommended wrought metal and insisted that boiler parts should be cylindrical and as thin as possible with due regard to stress. He urged small diameters and small water and steam spaces. He condemned fusible plugs. He favored water-tube boilers with horizontal tubes and small drums (never over 16 in. in diameter). He even recommended painting the internal surface of drums to prevent corrosion, and finally he laid down the axiom that the heated gas should cross the tubes at right angles, and that the grate should be so far below the tubes that the flame will not touch the tubes until combustion is complete. He repeatedly mentioned the necessity of keeping the tubes full of water—that is, keeping them far below the water level—and set forth the fact that the steam bubbles in high-pressure boilers are much smaller than in low-pressure boilers. He actually worked at pressures from 200 to over 1,200 lb. per square inch.

In practice it has been observed that all reasonable boiler designs can be made to operate at reasonably high efficiencies. Boilers so widely different as the Lancashire and Babcock & Wilcox types, when tested by careful experimenters, have developed equally high efficiencies. The design problem then becomes a question of capacity versus cost.

Certain operating desiderata must be considered. Inspection and cleaning must be easy. Circulation must be sufficient. The gas must be brought into intimate contact with the heating surface, and, finally, steam making, superheater, economizer, and air heater surfaces should be proportioned for the work the boiler is designed to do. From the manufacturing side the parts should be small but not too small, combining light weight with strength, easily and quickly put together and easy to replace. It is from

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Abstract of a paper presented at the spring meeting of the American Society of Mechanical Engineers, Pittsburgh, Pa., May 14 to 17, 1928.

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After discussing or alluding briefly to the history of the development of the high-pressure boiler, Mr. Orrok discusses the path of future development, mentioning a number of points that must be carefully considered.

* * *

such considerations that the modern water-tube boiler has developed.

Most of the water content of a boiler is in the tube bank, the drum rarely containing as much as 15 per cent of the total water content. The weight of water in a boiler with 1-in. tube will not exceed 0.9 lb. per sq.ft. of heating surface, which increases to about 3.5 lb. per sq.ft. of surface for the standard 4-in. tube, and is directly proportional to the internal diameter of the tube.

Effect of Tube Inclination

Many experiments have been undertaken to determine what inclination of boiler tubes is most conducive to evaporative capacity and efficiency. After citing a number of these, the author concludes that as a matter of fact equivalent efficiencies have been obtained with tubes of practically all slopes.

Circulation

In shell boilers circulation is a serious problem, but with the water-tube type the difficulties do not appear to be of such moment. We may say that the circulation velocity in water-tube boilers of the Babcock & Wilcox type varies from 2 to 20 ft. per sec. under usual conditions. Tests indicate velocities in vertical or nearly vertical tubes approaching 75 ft. per sec. In certain types approximating the flash boiler the water circulates only once through the tubes, with low circulation velocity, of the order of 2 ft. per second.

We may take it as a fact that with water-tube boilers circulation may be rapid or sluggish, depending on the arrangement, and that the more nearly the boiler approaches the flash type the slower is the circulation. As a corollary to this conclusion we may state that the water content of a boiler and the necessity for speed in circulation increase with the departure in type from the flash boiler and must be at their maximum in a shell boiler. Since the size of steam bubbles decreases with rising pressure, the percentage of solid water increases and circulation at high pressures may be more sluggish without detriment to boiler operation. This leads to the Benson contention that the best results should be obtained at the critical point (3,200 lb. per sq.in.) where steam and water have the same density and no bubbles exist.

Releasing Surface and Steam Space

The author points out that the ratio of heating surface to releasing surface varies from about 3.5 to 7,000 in boilers of various types. Since all these boilers prime occasionally and all can be run without priming, it will be seen that releasing surface has nothing to do with priming. As a matter of fact, priming will not occur unless the boiler

water is impure or soapy, owing to the presence of colloids. This is a matter of feed-water treatment. Entrained water is a different thing and will occur in all boilers to a greater or lesser degree, depending on the location of the tubes entering the drum, and the dry pipe arrangement. Superheaters should not be used for evaporators, and the releasing surface should be such that under maximum conditions particles of water should not reach the dry pipe.

The ratio of heating surface to steam volume also varies widely—from about 4 to 150. All the high-ratio boilers make special provision for feed-water regulators and safety valves, and these appear to be necessary.

It should be noted that either a time element—that is, steam storage space—or pressure reduction—that is, throttling of the steam—appears to be necessary to good running.

In general, because of the lower specific volume of the steam, high-pressure steam needs less releasing surface and steam space than low-pressure steam. Boilers should work better at high pressure, and much less trouble is to be expected with increasing pressures.

Safety in Operation

As a general rule that design is safest that has the smallest volume of water content, since "superheated water" is the chief source of danger in a boiler; therefore, drums should be made as small as possible. The tearing of drum sheets, so common in explosions of low-pressure boilers, should not occur in high-pressure work. It has been observed by all operators of high-pressure boilers that split tubes or bulges that open do not lead to explosions.

Increase in Capacity

The most important development in boilers in the Twentieth Century is the great increase in capacities that are now being secured from all types of modern boilers. An evaporation rate of 15 or 20 lb. per square foot per hour, at good efficiency, has now been secured, and 25 to 30 lb. is in sight. This exaggerates the wide variation in water level with sudden decrease in load. In flash boilers and in boilers above 600 lb. pressure this difficulty is not of much moment, but at pressures from 200 to 600 lb., at high ratings, as much as 40 per cent contraction may be encountered and the water level brought well down into the tube body. In spite of opinion to the contrary it is a question whether a dropping of the water level into the tube bank of high-pressure boilers is a dangerous proceeding. To the author such a procedure is much less of a menace than an additional drum with its content of superheated water.

Recent study has thrown considerable light on the behavior of boiler materials under stress. Fatigue phenomena are apparently reasonably consistent and only rarely enter into the boiler problem. Creep phenomena, on the other hand, are still highly controversial. The author presents curves showing the diversity of current opinion and stresses their bearing on boiler design.

Hot points on the high-pressure boiler

1. It must consist largely of banks of tubes.

2. Headers of great variety are available up to 1,400 lb. pressure.

3. Drums must be of small diameter, even when forged, and should not contain more than 10 per cent of the water content of the boiler.

4. Many good designs are available if the usual canons of boiler design are followed.

5. Up to at least 1,000 lb., there will be no necessity for alloy steels, but above this alloy steels should be used if the temperature margins so require.

6. High-pressure work will show less difficulties of operation than lower pressures.

7. For higher superheat than 800 deg. F., alloy steels are indicated.

8. Contemporary technical literature shows twenty or more different designs of boilers operating successfully at pressures over 500 lb., with at least six entirely different designs working over 1,000 lb. and one type is working at 2,000.

9. There is nothing to show the best design, since all types work well, and differ only in capacity and in the care with which details have been worked out.

10. Test data are insufficient to show real efficiencies, but enough has been done to show that the efficiencies of high-pressure boilers are comparable to those obtained at lower pressures.

Temperature Margins

For any given stress prevailing in a structural member, there is a temperature at which creep begins and above which it increases. The difference between this lower temperature limit of creep and the actual temperature prevailing in the member has been defined as the "temperature margin." Previous studies have indicated that this margin is too small in many actual cases. The author shows curves calculated for a 4-in. boiler tube of minimum Boiler Code thickness, for pressures from 200 to 1,400 lb. per sq.in. The temperature margins, which may be called margins of safety, range from 480 to 600 deg. at 200 lb., down to 70 to 185 deg. at 1,400 lb. From experience with high- and low-pressure stations here and in Europe it would appear that a 200-deg. temperature margin is safe for ordinary work.

Stresses in Superheater Tubes

The author presents curves showing values of temperature margin for convection superheater tubes, varying from 400 deg. at 200 lb. to 200 deg. at 1,400 lb., calculated for a heat transfer rate of 10,000 B.t.u. per hour per square foot, which is somewhat higher than ordinary practice. Radiant superheaters suffer more severe punishment, since the transfer rate may be as high as 60,000 to 70,000 B.t.u. per hour per square foot, although the highest reported is around 30,000. Temperature stresses play an important part, and the total stress is about twice that occurring in a convection type superheater for the same pressure. The temperature margin has been reduced to 250 deg. at 200 lb., is only 200 deg. at 500 lb., and 100 deg. at 1,200 lb. Under these conditions the life of the superheater tubes must be short. Flooding is dangerous even at low pressures and would probably not increase the life of superheater tubes materially. No attempt has been made, so far as the author knows, to increase steam speed to the point where the 200-deg. temperature margin could be maintained. In general, with ordinary boiler material radiant superheaters are much more subject to trouble than the usual convection type. With alloy steels higher temperature margins may be obtained, and longer life may be expected at considerably increased first cost.

Riveted Drums

The author presents a table showing that drum thicknesses rapidly become unmanageable and at around 1,000 lb. pressure amount to more than 10 per cent of the drum diameter. He discusses briefly the manufacture of forged

and welded drums, and the dependability of subjecting a drum to a hydrostatic test that stresses the material above its elastic limit, measuring the deformation and subsequently annealing.

Some progress has been made in this country in the direction of drums and other boiler parts made in this way.

Drums of high-pressure boilers should be kept away from the fire. When properly protected by brick walls and arches, their surface ceases to be heating surface and is rarely hotter than the saturated steam temperature. Temperature margins are thus very high, in most cases over 400 deg., with little chance of surreptitious reduction.

Headers

While stresses in irregular-shaped headers are indeterminate, they may be taken as double the stresses in a circular header of equal area and thickness, with the usual allowances for ligament efficiency, etc. No design should be used without hydrostatic tests to destruction where the deflections at all weak points are accurately measured. Headers are now made from welded forge steel and open-hearth cast steel, from electric-furnace alloy cast steel, and swaged or forged from seamless drawn steel tubing. All these types are in satisfactory operation at the present time. As the header in most cases is directly exposed to the fire, temperature strains enter into the problem and thickness of metal should be kept as small as possible under the circumstances. Maximum strains, however, do not occur on the hot surface where support is secured from the tubes, but on the cold side in the neighborhood of the hand-holes, and in the oblique ligaments. The temperature margins are somewhat uncertain, but are around 400 deg. for most cases.

Superheater headers are often circular, and the stresses are determinate. The header is usually set apart from the flow of hot gas, and the temperature margins are high.

Water-wall headers are usually circular, and the stress can be determined by the usual methods, ligament efficiency being the critical factor. In many constructions these headers are entirely outside the path of the hot gas, and temperature margins are large, much in excess of 400 deg.

Conclusions as to the Best Type of High-Pressure Boiler Under Present Limitations

1. Very high-pressure boilers (2,000 lb. and over). Flash type, tubes 2 in. or less in diameter, no header, no drums, all welded joints, except at collectors and manifolds where flanged or cone joints should be used. These boilers may consist of a single coil for small outputs or multiple coils as in the Benson boiler.

2. High-pressure boilers (800-1,600 lb.). Waterlevel type, consisting of a bank of tubes of larger diameter than those indicated for the flash type, with wall thickness not to exceed one-tenth of the outside diameter. Tubes to be expanded in headers or small-diameter drums whose thickness when exposed to fire should not exceed one-tenth of the outer diameter. Water-line drum should not contain, when half full, more than 10 per cent of the water content of the boiler. The boiler should be high rather than low, so that the water in the tubes may be under sufficient static head to insure steadiness of steam, and restrictions in discharge opening to steam drums should be sufficient to obviate serious moisture in the steam. Dry pipes or separators should precede the superheater. Steaming economizers should not be used, but the feed water should be heated by economizer or the regenerative system, so that little water heating is left to be done by the boiler itself. Water-cooled furnace walls should be used in sufficient amount to make the furnace repairs a negligible quantity.

3. With temperatures above 750 deg. F., we must be content with a shorter life of tubes and be prepared to replace coils or tubes from time to time. The only alternative is the use of much higher cost alloy steel.

The author presents an appendix showing his method of computing thermal stresses in boiler tubes.

Discussion

Mr. Orrok's paper called forth considerable discussion. Alfred A. Markson called attention to various factors affecting the delivery of dry steam, such as the rate of steaming and the total steam upcomer area, in addition to feed-water purity.

Owing to the indeterminateness of circulation in many boilers, he declared it is difficult to figure upcomer area. The releasing area should always exceed the upcomer area. Boiler circulation, said Mr. Markson, is of great importance. A boiler with more rapid circulation will have smoother steam disengagement and steadier water level. Tube inclination, he said, has a definite influence on circulation and on water downcomer capacity. The solution of the problem must be found in rational boiler design, Mr. Markson concluded.

O. H. Hartmann, of Kassel-Wilhelmshöhe, Germany, sent in a written discussion agreeing with Mr. Orrok on most points and discussing recent German practice in the indirect generation of steam, which he thinks is the best method for high-pressure work.

F. N. Speller, Director of Metallurgy and Research for the National Tube Company, called attention to the importance of considering local boiler corrosion in high-pressure plants. So-called "corrosion fatigue" has perhaps not been noticed in high-pressure boilers as yet, but it seems to explain failures in other structures, according to Mr. Speller.

A. D. Bailey disagreed with the statement that "steaming economizers should not be used," saying that the one installation that he knows about is performing very well.

Refrigeration Leaders Meet in Washington

A LUNCHEON on May 10 at the Washington Hotel, Washington, D. C., served as the vehicle to usher in the seventeenth annual meeting of the American Institute of Refrigeration.

A report on the Fifth International Congress of Refrigeration at Rome, Italy, by J. F. Nickerson, chairman of the American Delegates, held the attention of those attending.

Mr. Nickerson pointed out that as a result of shifting the date of the Rome Congress from September, 1927, to April, 1928 several of the American delegates were unable to attend. In addition, so he reported, no preprints had been made of the many papers presented before the Congress, and consequently the discussions were not as complete nor as valuable as they usually are.

The attention of the delegates was called to "The Practical Engineers' Responsibility to the Refrigerating Industry," by Fred I. McCandlish, president of the National Association of Practical Refrigerating Engineers. Mr. McCandlish pointed out that the ice and refrigerating industry was giving too much time to the essentially business, or sales, problems to the exclusion of production problems. How efficiently a plant is being operated by the engineer is seldom known, and as a result costs are far higher than need be.

There is too little effort made to build up a spirit of co-operation between the engineers and the managers. Good men are discharged at the beginning of winter without any consideration given to the question of how and where they will make a living until spring arrives. The Southern Ice & Utilities Company, with which the speaker is connected, never discharges a loyal worker. When a plant is shut down in the fall, the engineers and other men are put to work on overhauling, new construction, etc. They are frequently sent to other plants when additions are being made and when away from home are paid their living expenses. In other words, the arrival of winter has no ill effect on their economic position.

In addition, the men are encouraged to take up extension courses in engineering, and frequent meetings are held at which the supervising engineer discusses basic principles of refrigeration. The speaker was positive that as a result of this more intelligent handling of the labor problem, operating costs had been materially reduced.

Other sessions were devoted to reports from the various associations making up the Institute's membership. It was the feeling of those present that the associations were not as cordial in their support as is desirable.

P. W. Switzler, St. Louis, Mo., was re-elected as president, while Louis Baron, New York City, was chosen as executive secretary for a second term.

TWO UNUSUAL POWER PLANTS

Outstanding Subjects at A.I.E.E. Regional Meeting

AT THE American Institute of Electrical Engineers Regional Meeting, held in New Haven, Conn., May 9 to 12, two papers were presented that are of particular interest to power engineers. One of these, "Rocky River Hydro-Electric Development of the Connecticut Light & Power Company, presented by E. J. Amberg, describes a project near New Milford, Conn., which is a storage development for regulating the Housatonic River.

There are no sites on the main river suitable for large storage reservoirs; it was therefore necessary to select a site on a tributary, the Rocky River. The run-off from the natural drainage area of the reservoir furnishes only a part of the water required to fill the reservoir, making it necessary to pump the balance from the Housatonic River against a maximum head of 240 ft. This is the first large installation of pumped storage in the United States, which attaches unusual interest to the development.

The project as now constructed has a storage reservoir with a useful capacity of nearly six billion cubic feet, and a power house that contains a 33,300-hp. generating unit and two 8,100-hp. motor driven pumps. These pumps are the largest in this country for a 240-ft. head and will each deliver 112,500 gal. per minute.

When presenting his paper, Mr. Amberg compared the Rocky River reservoir to a large storage battery. Charging the battery is accomplished by secondary power from a steam plant driving the two centrifugal pumps, which take water from the Housatonic River and deliver it into the reservoir. The battery is discharged by means of the generating unit, using the stored water to deliver primary hydro-electric power to carry the peak load.

Efficiency of Conversion

The efficiency of this storage battery for changing secondary steam power to primary hydro-electric power is 61 per cent. This conversion includes all losses from the 66,000-volt busbar at the steam plant, through the pumping unit into the reservoir, and back through the generating unit to the 66,000-volt busbars at Rocky Point plant. In other words, for every 100 kw.-hr. supplied by the steam plant in filling the reservoir, 61 kw.-hr. are delivered by the Rocky River generating unit, when the water is taken from the reservoir.

Below Rocky River plant there is an additional total average head of 191 ft. available, of which 71 has been developed. If this developed head is added, then for every 100 kw.-hr. of steam power, 79 of hydro-electric is returned. If the total head from Rocky River to tidewater is utilized, 111 kw.-hr. of hydro-electric power could be obtained for every 100 kw.-hr. of steam power used in pumping.

When discussing this paper, J. D. Justin said that in Europe there were some 35 or 40 hydro-electric developments either projected or in operation that used pumped water. Mr. Justin referred to one project in the Ruhr which had two reservoirs, the tailrace and the forebay. During the off-peak hours the water is pumped from the tailrace into the forebay, which is used in the hydro-electric units to supply the peak load on the system. The head on this project is 540 ft., and the plant has a generating capacity of 180,000 hp. in four 45,000-hp. units.

HYDRO-ELECTRIC plant equipped with one 33,300-hp. generating unit and two 8,100-hp. pumps, uses steam generated power to pump water into a reservoir to operate the waterwheel generator. Mercury boiler and turbine rated at 10,000 kw., in combination with a steam unit, will produce a kilowatt-hour on 10,000 B.t.u. in the fuel. The mercury vapor will have a pressure of 70 lb. and a temperature of 884 deg. F.

Mercury Boiler

The second paper dealt with the 10,000-kw. mercury boiler and turbine being installed in the plant of the Hartford Electric Light Company, and was presented by L. A. Sheldon. When presenting his paper, Mr. Sheldon said that mercury is an element and does not decompose at high temperatures. It boils at atmospheric pressure at 675 deg. F.; at 70 lb. gage pressure, 884 deg.; and at 165 lb. gage, 1,000 deg. Therefore it is possible with mercury to go to temperatures much higher than is possible with steam alone and to do this at comparatively low pressures.

In the Hartford boiler a pressure of 70 lb. gage and 884 deg. F. temperature will be used. This temperature is about 300 deg. higher than that corresponding to the highest steam pressure used in this country. While it is true that with high-pressure steam something is gained by superheating, owing to the fact that the energy involved in superheating is small, this gain cannot be large. With mercury the high temperature is by means of pressure alone and a high efficiency results.

In this system mercury is boiled and vaporized over a fire just as water is boiled and vaporized in a steam boiler. This mercury vapor then drives a mercury turbine just as steam drives a steam turbine in an ordinary system. At the exhaust of this turbine the mercury vapor is still hot enough to boil water and make steam at pressures which are in common use. Therefore, instead of running water through the condenser as in the ordinary steam condenser, a level of water is held in this condenser just like a steam boiler. The water boils and makes steam.

In the Hartford equipment the designed steam pressure is 350 lb. gage, but it will be operated at about 275 lb., which is the line pressure of the station. The mercury condensate falls to the bottom of the condenser and, from there, runs through a sump where it is continually cleaned, and then to the mercury liquid feed heater and on to the mercury boiler. The equipment has been arranged so that the mercury turbine and condenser boiler are on the floor above the mercury boiler, and the mercury returns to the boiler by gravity.

Mr. Sheldon said that the Hartford equipment, when running at full load, should deliver a kilowatt-hour to the switchboard for about 10,000 B.t.u. in the fuel. But this is not the ultimate economy that may be expected with the mercury cycle, since with possible refinements in design a kilowatt-hour at the switchboard might be expected for about 8,500 B.t.u. in the fuel.

NEWS OF THE FIELD

The editors will welcome the co-operation of readers in reporting interesting happenings, personal or otherwise

U. S. Chamber of Commerce Holds Sixteenth Annual Convention

Unethical business scored—Plea made to keep government out of business—Federal Trade Commission opposed to investigations not based on law

THE Chamber of Commerce of the United States at its May 10 general session put its formal stamp of approval on the principles set forth in the keynote address of Judge Edwin B. Parker. In a resolution, unanimously adopted, unethical practices in business were condemned and stockholders were told that they "cannot accept the profits flowing from corruption and escape the moral stigma which inheres in such profits."

The resolution declared further that American business "insists upon protecting its professional status by the maintenance of the highest standards and intends scrupulously to discharge its collective responsibilities."

William E. Humphrey, chairman of the Federal Trade Commission, declared that he is utterly opposed to any investigation initiated by the Federal Trade Commission that is not based upon alleged violation of law. "One of the highest and the most sacred rights of every honest business is the right to be let alone. The Federal Trade Commission has sufficient to do to control the crooked, without prosecuting the honest."

Thursday morning's session was devoted to subjects that particularly concern trade associations. William E. Humphrey reviewed the work of that body during the last three years. At that time, the Commission first announced the change in its policy whereby it abandoned the practice of publishing complaints before the defense was heard. Under the new procedure more dishonest businesses were closed up and a greater number of steps taken to protect the public than in the entire preceding thirteen years of the Commission's life. This record, Mr. Humphrey believed, proved the soundness of the new policy.

He laid particular stress on the trade practice conferences through which an industry is given opportunity to meet under the chairmanship of the Commission and set up its own code of ethics and of business practice. Under this plan bad practices have been eliminated from a great many industries.

Alfred Reeves, general manager of the National Automobile Chamber of Commerce, made a great impression on his audience by reciting in considerable detail the co-operative efforts of the automobile manufacturers. He cited the great benefit from the system of cross licensing of patents, whereby every member of the Chamber can use all the patents of every other manufacturer member without royalty. There are now 700 patents under the cross licensing agreement. As a result, there has been no patent suit in 14 years. Resulting from the interchange of patents, the whole industry has been able to progress rapidly through the joint use by all of the best ideas of each manufacturer.

The keynote of the session of the Natural Resources Production Department on May 8 was "power and prosperity." While Chairman M. S. Sloan, president of the Brooklyn Edison Company, considered the conditions and trends in the development of such natural resources as forests, minerals and water, the burden of his address was a defense of the Federal water power policy and a plea to keep the government out of the power business.

R. F. Pack, vice-president and general manager of the Northern States Power Company, of Minneapolis, showed how teamwork and group management worked in the power industry. He outlined the service and economic advantages of the holding company and stressed the necessity of greater teamwork in business, especially in checking government competition with legitimate business enterprises.

R. E. Norton, vice-president of C. H. Geist Securities Corporation of Philadelphia, traced the struggle of the power industry in raising money for development purposes in the years prior to 1920 and how since then there has been an enormous growth in fixed capital in the electric public utility industry, made possible by a change to enthusiasm on the part of the investor because of his belief in the integrity and the future of the business.

The new Chamber of Commerce building, Washington, D. C.

"There can be no civilization without order and no order without law," according to Silas H. Strawn, chairman of the Board, Montgomery Ward & Company. He said that the greatest peril to this country today is the indifference and apathy of our business men toward the problems of government, and that if business is to continue to prosper business men must give more attention to what is going on in Congress.

At the luncheon meeting of the Manufacturing group, E. J. Mehren, vice-president of the McGraw-Hill Publishing Company, in an address "Teamwork

for Profits in a Buyers' Market," proposed that (1) the craze for volume be supplanted by a reasonable passion for profits, and (2) that buyers' profiteering with its accompanying price cowardice be eliminated.

Another address delivered at the luncheon meeting of the Manufacturing group, important because of its wealth of detail, was that of Donaldson Brown, vice-president of the General Motors Corporation, under the title, "Forecasting and Planning Vital to Industrial Prosperity." The methods of forecasting and planning in use by the General Motors Corporation were explained.

The Board of Directors of the Chamber of Commerce, following conclusion of the Chamber's Sixteenth Annual Convention, elected the following officers for the ensuing year:

Chairman of the Board of Directors, Joseph H. Defrees, of Chicago; president, William Butterworth, of Moline, Ill., president Deere & Company; vice-president eastern division, Alfred J. Brosseau, of New York, president, Mack Trucks, Inc.; vice-president south central division, Robert R. Ellis, Memphis, Tennessee, president, Hessig-Ellis Drug Company; vice-president, north central division, Robert P. Lamont, Chicago, president, American Steel Foundries; vice-president western division, Paul Shoup, San Francisco, executive vice-president, Southern Pacific Company.

Second National Fuels Meeting Convenes in Cleveland

The Second National Fuels Meeting will be held in Cleveland, Ohio, Sept. 17-20, 1928. The Fuels Division of the American Society of Mechanical Engineers is devoting considerable time and thought to the preparation of a well-rounded and broad selection of subjects. In addition to the technical program arrangements are being made for a number of inspection trips to the leading plants in the vicinity.

The papers for the Cleveland meeting will cover the use and production of solid, liquid and gaseous fuels in all fields and will be of general and specific interest to the producer and distributor, the central-station engineer, the large and small industrial power engineer and the marine and railroad engineer.

Attendance to, and participation in, the National Fuels Meeting is not limited to the membership of the American Society of Mechanical Engineers. The meetings are exactly what their title implies—National Fuels Meetings. They are for anyone interested in the production, distribution or utilization of fuels. The meetings are intended to be central agencies where all the facts and problems relating to fuels and heat may be discussed and studied, and through which information may be disseminated to all who are interested in fuel and heat problems. It is, therefore, essential that these meetings be participated in by all engineers, executives and others who are interested in this line of work.

Berry Succeeds Davis at Harvard

C. Harold Berry, for nearly three years Associate Editor of *Power*, has been appointed Professor of Mechanical Engineering in the Engineering School of Harvard University, to succeed Dr. Harvey N. Davis, who was recently elected to the Presidency of Stevens Institute. The appointment is effective Sept. 1, 1928.

Prior to his connection with *Power*, Mr. Berry was with the Detroit Edison

C. Harold Berry

Company as technical engineer of power plants, responsible for testing and operating economy in the four steam generating stations of that company, and before that he was Assistant Professor of Heat Power Engineering in Sibley College, Cornell University.

Mr. Berry has been active in the A.S.M.E. as a member of the Power Tests Code Committee, and of the subcommittee on Steam Turbines. He is also secretary of the Metropolitan Section of the A.S.M.E.

Power greatly regrets the loss of its Associate Editor and wishes him success in his new undertakings.

Remodeling Cahokia Station Includes 75,000-kw. Turbine

The Union Electric Light & Power Company, of St. Louis, has made plans to remodel and expand the Cahokia station, the largest of its generating plants. The plans include the installation of a General Electric turbine-generator of 75,000 kilowatts.

Instead of making an addition to the present station building, space for the 75,000-kw. unit will be provided by removing a 30,000-kw. machine. The foundations of this machine will be strengthened to suit the larger unit, and the condenser which was used with the 30,000-kw. turbine will be altered and connected to the new 75,000. The unit which is removed will be installed in the Venice station of the company, which is adjacent to the Cahokia station.

In adapting the old condenser for use with the new turbine, steam will be bled from two stages and will be used to heat the feed water from this unit as well as that from a 35,000-kw. machine already in the station.

The new turbine will be a single-cylinder machine receiving steam at 315 lb. gage, 300 deg. F. superheat, and will operate against a back pressure of 1 in. absolute. It will be rated 75,000 kw. at 1,800 r.p.m. The generator will be rated 60 cycles, 13,800 volts, three-phase, and 90 per cent power factor.

Holland Plant, N. J., to Operate at 1,200 lb. Pressure

The New Jersey Power & Light Company is building the first 50,000-kw. unit of a 200,000-kw. ultimate capacity plant at Holland, N. J., on the Delaware River, about eight miles below Easton, Pa. It will be the main generating plant on the eastern part of the Pennsylvania-New Jersey System.

The boiler units are being built for 1,400-lb. steam pressure to allow ample pressure drop between boiler drums and 1,200-lb. pressure at turbine throttle. Before adopting 1,200 lb. as the operating pressure, studies of the 400-, 600- and 1,200-lb. plants were made, and based on $5 per ton coal and 50 per cent load factor the 1,200-lb. plant was selected as the most economical.

Two identical boiler units consisting of water walls, boiler, superheater, gas and steam reheaters, economizer and air heater will generate 250,000 lb. of steam per hour each at 1,400 lb. pressure, 750 deg. F., and reheat at approximately 400 lb. pressure to 750 deg. F. Reheaters are integral with the boiler unit, and the reheat temperature is held constant through the entire range of operation by means of the steam reheater.

Pulverized fuel will be used from a bin system. Mill drying will be used, and vents from the mills will be discharged into the furnace through the burners, thereby eliminating expensive driers and objectionable features of mill vents.

The 50,000-kw. turbine will be of the cross-compound type, the high-pressure unit operating at 3,600 r.p.m. and the low-pressure unit at 1,800 r.p.m., the ratio of the capacities of the high-pressure unit to the low-pressure unit being in the order of 1 to 4. As the units are tied together electrically, the reheat pressure varies with the load but the reheat temperature is maintained constant. With this method of operation a very flat B.t.u. consumption curve is obtained.

It was realized that to build a 1,200-lb. plant for high efficiency at variable load operation, the turbine must be of the multi-valve type to give the high-pressure turbine a greater range of expansion at fractional loads, and that means for maintaining constant reheat temperature would have to be obtained. This has been the aim in the selection of the various equipment.

The condenser will be of the single-pass type with tubes rolled at both ends to prevent condenser leakage. Four stages of feed-water heating by bled steam will be used, delivering water to the economizer at approximately 400 deg. F.

The foundation work is under way now, and it is expected that the plant will go into operation during the latter part of 1929. The design and construction work is being done by W. S. Barstow & Company, Incorporated.

Consolidated Gas and Brooklyn Edison Combine

The merger of the Consolidated Gas Company, of New York, and the Brooklyn Edison Company, gives the Consolidated Gas Company a total capital in excess of $1,064,625,000 and a total generating capacity of about 1,505,000 kva. With this merger this company becomes the second largest public utility in the United States, exceeded only by the American Telephone & Telegraph Company, which has assets of approximately $1,950,000,000. The Consolidated at present controls the New York Edison Company, the United Electric Light & Power Company, the New York & Queens Electric Light & Power Company, and the Bronx Gas & Electric Company. Only two independent utilities are now operating in the metropolitan district, the Brooklyn Union Gas Company and the Long Island Lighting System.

The consolidation program will be submitted to the Public Service Commission of New York and it is expected to be carried into effect by midsummer.

Berlin Extends Its Power Plant Capacity

Important extensions to the existing capacity of the Berlin power stations will be necessary during the next five years in order to cope with the greatly increased demand for power. In the last few years the maximum load of the Berlin Municipal Electricity Supply Company (BEWAG) has increased by 20 per cent yearly. Since 1924 the peak load has risen 40,000 to 50,000 kw. a year. At present the total capacity at the disposal of the company is about 500,000 kw.

It is estimated that the total load in 1932 will be 720,000 kw. As a reserve of 25 per cent is considered necessary, the existing capacity will have to be practically doubled. The reserve capacity, which amounted to 28.8 per cent during the last winter, is expected to fall to 16.8 per cent during the winter of 1928-9, in spite of the installation of a new generator set of 20,000 kw. in the old power station at Rummelsburg, and the taking over of the Stadtische and Kreiskraftwerk at Spandau by the BEWAG.

In order to meet the anticipated demand, during the coming winter batteries will be employed for peak-load work; in the past these have only been used for coping with breakdowns. In 1929 a Ruths accumulator plant with a capacity of 40,000 kw. will be in operation at the Charlottenburg power station, as well as an additional generator for 25,000 kw. at Spandau. Additional capacity of 50,000 kw. will also be available from the Electrowerke.

The greatest increase in capacity will be furnished by a new power station, the Westkraftwerk, to be constructed in the region of Spandau at an estimated cost of 54,000,000 marks. Construction of this station will be started this year. The first generator set, with a capacity of 90,000 kw., is to be placed in operation in 1930, and the second in 1931. This station will be used as a peak-load station. The installation of Benson boilers operating at 224.2 atm. (3,200 lb.) has been considered for this station.

Coming Conventions

American Association of Engineers, annual convention, El Paso, Texas, June 4-6; M. E. McIver, secretary, 63 Adams St., Chicago.

American Boiler Manufacturers Association, annual convention, at Buckwood Inn, Shawnee-on-the-Delaware, Pa., June 11-13; A. C. Baker, secretary, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers, annual Summer convention at Denver, Colo., June 25-29; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Order of Steam Engineers, convention at Atlantic City, N. J., June 11-14, and exhibition with American Supplymen's Association. Address Fred L. Jahn, Watson of McDaniel Company, 146 N. Seventh St., Philadelphia.

American Society of Refrigerating Engineers, meeting at Detroit, June 4-7; W. H. Ross, secretary, 37 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, Summer meeting at West Baden Springs Hotel, West Baden, Ind., June 26-29; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, first national oil and gas power meeting at State College, Pa., June 14-16; Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3; second national fuels meeting at Cleveland, Ohio, Sept. 17-20; Calvin Rice, secretary, 29 West 39th St., New York City.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention and Iron and Steel Exposition at Hotel Stevens, Chicago, June 25-29.

Canadian Steel and Power Show at the University of Toronto Arena, Sept. 4-7; Campbell Bradshaw, secretary, 24 Front St., West Toronto, Canada.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago. New England States Association convention at Hartford, Conn., June 21-23; K. W. Lundberg, secretary. Foot Guard Armory, Hartford. New Jersey State convention at the Plaza Hotel, Journal Square, Jersey City, N. J., June 2-3; T. M. Gray, State Secretary, 46 West 51st St., Bayonne, N. J.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Carbon Brushes and Brush Shunts Standardized

A sufficient number of written acceptances having been received for Simplified Practice Recommendation No. 56, "Carbon Brushes and Brush Shunts," recently revised by the industry, the Division of Simplified Practice, Department of Commerce, announces that the project is now in effect, as of Nov. 1, 1927, subject to annual revision or reaffirmation by the industry.

Eighty per cent of the known manufacturers, distributors, and organized users of the specific commodity must accept the recommendation in writing before it can be placed in effect by the Department of Commerce.

This recommendation, as originally developed by the industry, provided increments of increase in dimensions, and dimensional tolerances for carbon brushes, sizes of holes or slots in terminals for flexible shunts, and size and specifications for cable for brush shunts.

Another Ship Installs Pulverized Coal

Converted by the Halifax Shipyards, Ltd., to burn pulverized coal, the steamer "Lingan," owned by the Dominion Coal Corporation of Canada, is now on a series of trial trips off Halifax prior to being turned over to her owners. She is the first privately owned vessel to be so equipped. The "Mercer," of the U. S. Shipping Board fleet, is the only other boat equipped to burn pulverized fuel.

The vessel, a single deck collier, 375 ft. long, with a 52-ft. beam and a depth of 30 ft., was built at Middlesboro, England, in 1911. She is 4,677 gross tons, has three Scotch marine forced-draft boilers which deliver steam at a pressure of 180 pounds.

Installation of a Kennedy VanSaun air-swept ball-type pulverizing mill on the port and the starboard side of the vessel will pulverize the coal to not less than 70 per cent through a 300-mesh screen.

Invitation to the Power Field

THE Smithsonian Institution is planning a permanent steam power plant engineering exhibit in the U. S. National Museum at Washington. The subject is to be treated both historically and from the point of view of modern practice.

The Museum authorities are anxious to locate specimens of the earlier steam engines, especially those illustrating the development in this country between 1755 and 1803. Information of any sort relative to the engines of Watt, Evans or Roosevelt will be welcomed.

The Museum would also like to have information regarding appropriate exhibition material for the modern parts of the proposed exhibit. Many power-plant engineers, sales engineers and erection men are aware of power-plant equipment that would be most suitable and acceptable to the Museum, while many organizations have or might be interested in preparing educational material visualizing modern practice which would be suitable for carrying out the Museum's plans.

OBITUARY

THOMAS P. BURKE, for 30 years a resident of Pawtucket, and for 25 years head of the Burke Engineering Company, Providence, R. I., died at Lawrence Memorial Hospital, New London, Conn., from injuries received when he was struck by an automobile in Niantic, Conn. Mr. Burke was formerly president of the Pawtucket N.A.P.E. and was probably one of the most influential and best known members of the N.A.P.E. in New England. He was born in Richmond, Va., and was in his 67th year at the time of his death.

ARTHUR W. GUCKER, aged 47 years, for several years manager of the Carroll, Iowa, plant of the Iowa Public Service Company, died suddenly at his home May 6.

A.I.E.E. Summer Convention Includes Tour of Yellowstone Park

During the five days, June 25 to 29, the American Institute of Electrical Engineers will hold its Summer Convention at Denver, Colo., with headquarters at the Cosmopolitan Hotel. Among the papers to be presented are four on high-speed circuit breakers, "Operation of Machines at High Altitudes," by H. S. Evans; "Alternating Current Elevator Motors of the Squirrel-Cage Type," by E. E. Dresse; and "Electric Welding of Pipe Lines," by J. O. Dwight.

A feature of the convention will be a tour that will include Yellowstone Park and will pass through Colorado Springs and Salt Lake City. This tour, which will start from New York and take in the convention, will require eighteen days. All arrangements for railroad and Pullman tickets, hotels, automobile tours, etc., will be made by

PERSONALS

J. H. STRICKLER, for the last three years manager of the Arkansas Public Service Company's plant at Ola, Arkansas, has resigned and accepted a position as field manager with the Central States Power Company, of Des Moines, Iowa.

WALTER KIDDE, acting chairman of the Board of Trustees of Stevens Institute of Technology, at Hokoben, N. J., announced on May 14 that the Board had created a new position of vice-president of the Institute, and that James Creese, now general secretary of the American-Scandinavian Foundation, had been elected to fill it. He has also been appointed treasurer of the Institute.

HENRY C. MCELDOWNEY, president of the Union Savings Bank and the Union Trust Company, Pittsburgh, Pa., was elected a director of the General Electric Company at an organization meeting of the board held in Schenectady May 8. Gerard Swope, president, and all other officers of the company were re-elected.

KENNETH C. HARLAN, public utility engineer of Tacoma, Washington, has been engaged by the City Council of Portland, Oregon, to make an investigation into the light and power rates of the Portland Electric Power Company.

JAMES H. LONGLEY, manager of the production and transmission department of the Tennessee Electric Power Company at Chattanooga, Tenn., has been appointed assistant to the general manager of the company. O. J. Miller has been appointed to succeed Mr. Longley as manager of the production and transmission department.

H. M. ELDER, formerly superintendent of power plants with the American Locomotive Company, has retired from active work and has taken up permanent residence at Failie, Ayrshire, Scotland. the travel bureau which has been organized for the trip.

BUSINESS NOTES

THE ERIE CITY IRON WORKS, Erie, Pa., has established a direct sales office at 1105 Leader Building, Cleveland, Ohio, with Eugene Smith as district manager.

THE AFCO PRODUCTS COMPANY, manufacturer of a scale and rust remover and preventive, has moved its main office from New Haven, Conn., to 11 West 42nd Street, New York City.

THE LINDE AIR PRODUCTS COMPANY has opened a new district sales office at 48 West McLemore Avenue, Memphis, Tennessee.

THE GRISCOM-RUSSEL COMPANY announces that it has recently acquired the major portion of the Russel company's plant adjoining its own works at Massillon, Ohio. By the addition of

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.60
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	1.75@ 2.00
Smokeless	Chicago	1.65@ 2.00
S. E. Kentucky	Chicago	1.35@ 1.75
Steam	Pittsburgh	1.40@ 1.80
Gas Slack	Pittsburgh	1.15@ 1.25
Big Seam	Birmingham	1.40@ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Birdseye	New York	1.60

FUEL OIL

New York—May 17, industrial use, tank-car lots, 28@34 deg., Baumé, 5c. per gal.; 36@40 deg., furnace, 6½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—May 10, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.52½ per bbl.; 26@28 deg., $1.57½ per bbl.; 28@30 deg., $1.62½ per bbl.; 30@32 deg., $1.67½ per bbl.; 32@36 deg., gas oil, 4.27c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—May 1, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., 5¾c. per gal.

Philadelphia—May 14, 26@30 deg., $2.07 per bbl.; 13@19 deg., $1.22 per bbl.; 22 plus, $1.48@$1.55 per bbl.; 27@30 deg., $2.17 per bbl.

Cincinnati—May 8, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—May 5, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90@95c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—May 14, tank-car lots, f.o.b. 12@14 deg. Baumé, 4½c. per gal.; 28@32 deg., 5.65c. per gal.

Dallas—May 12, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

this new plant the company has secured the needed manufacturing facilities for its heat transfer apparatus.

CONSOER, OLDER & QUINLAN, INC., consulting engineers, Chicago, have moved their offices to the Engineering Building, 205 W. Wacker Drive.

THE NATIONAL ALUMINATE CORPORATION, with general offices at 6216 West 66th Place, Chicago, announces that it has purchased the stock, names, patents, trade-marks, and good will of the Chicago Chemical Company and the Aluminate Sales Corporation, both of Chicago. The new officers are: Arthur Meeker, Chairman of the Board; H. A. Kern, president; P. W. Evans, vice-president, and H. J. Young, secretary-treasurer. Dr. G. J. Fink will remain at the head of the research department.

BAYLEY BLOWER COMPANY, Milwaukee, Wis., announces the promotion of Charles H. Jackson, chief engineer, to the position of general sales engineer, and the appointment of Ernest Szekely to succeed Mr. Jackson as chief engineer.

THE KUHLMAN ELECTRIC COMPANY, of Bay City, Mich., manufacturing power, distribution and street-lighting transformers, announces the appointment of the Enterprise Electric Company, 1425-35 M St., Lincoln, Neb., as representatives for that district.

TRADE CATALOGS

ELECTRIC MOTORS—Bulletin No. 1087 has recently been issued by the Reliance Electric & Engineering Company, Cleveland, Ohio. This bulletin has four pages and gives information on the application and protection of various types of electric motors. Particular attention is given to motors of the enclosed type.

RENEWABLE FUSES—The Trico Fuse Manufacturing Company, Milwaukee, has just announced a new bulletin 206-B describing TRICO "Powder-Packed" renewable fuses. It contains engineering data and tests on overload, time-lag and watt-loss saving.

LIQUID LEVEL GAGES — The Bristol Company, in its catalog No. 1800, illustrates and describes its complete line of indicating and recording liquid level gages in the round- and strip-chart types. Several disassembled views show the principle of operation and details of construction of the instruments and various diagrams and photographs show methods of installing as well as typical installations.

MASTER REGULATORS — In Bulletin No. 101, just issued by the Hagan Corporation, Pittsburgh, Pa., the construction details and operating characteristics of the Hagan Master Regulators are clearly set forth. The regulator is well illustrated by means of full-page cross-sectional line drawings with reference letters and general views showing the different diaphram and valve arrangements for various pressures.

BALL BEARINGS—The New Departure Manufacturing Company, Bristol, Conn., has just issued a pocket-size booklet containing useful information and engineering data on its line of ball bearings. The booklet contains revised tables of bearing types with load ratings at various speeds, correction factors for figuring capacities under combined radial and thrust loads as well as tolerances and fits.

SPEED REDUCERS — The Palmer-Bee Company, Detroit, Mich., has issued a 48-page catalog describing the PB-Sykes continuous tooth herringbone gears and the complete line of herringbone and improved mill-type spur-gear speed reducers. It also contains tables of horsepower ratings and dimensions of standard-sized units, together with instructions regarding their lubrication, installation, etc. Details of the Palmer-Bee high-speed flexible couplings, as well as charts showing typical layouts of speed reducer drives, are included.

NEW PLANT CONSTRUCTION

Compiled by the McGraw-Hill Business News Department, which is prepared to furnish a more complete daily service to those who wish it

California — Uttley & Kliendenst, 354 Hobart St., Oakland, Archts., are preparing preliminary plans for the construction of a cold storage plant. Estimated cost $350,000. Owners' name withheld.

Calif., Los Angeles — Lincoln Mortgage Co., c/o Allison & Allison, Hibernian Bldg., Archts., is having plans prepared for a 12 story office building on Flower St. Estimated cost $1,000,000.

Calif., Santa Cruz—City will soon award contract for the construction of a pumping plant.

Georgia—Crisp County Power Comn., J. J. Williams, Comr., Cordele, will receive bids until July 10 for the construction of a complete hydro-electric plant on the Flint River, near Warwick including two water wheel driven generators, etc. E. S. Killebrew, Albany, is chief engineer. J. E. Sirrine & Co., Greenville, S. C., are consulting engineers.

Ill., Chicago — Marshall Field & Co., Randolph, Wabash, Washington and State Sts., plans the construction of an 18 to 23 story merchandise mart at Wells, Kinzie, Orleans Sts. and Chicago River. Estimated cost approximately $15,000,000. Graham, Anderson, Probst & White, are architects.

Ill., Chicago—Foreman National Bank, 30 North La Salle St., awarded contract for a 23 story bank and office building at Washington and La Salle Sts. to Paschen Bros., 111 West Washington St. Estimated cost $10,000,000.

Ill., Chicago—Paschen Bros., 111 West Washington St., had plans prepared for a 23 story office and stores building including elevators, etc., at North Michigan Ave. and East South Water St. Estimated cost $4,000,000. Burnham & Co., 160 North La Salle St., are architects. Owners are general contractors.

Ill., Chicago—Walton St. Building Corp., c/o Levy & Klein, 228 North La Salle St., Archts., will soon award contract for an 18 story hotel at Walton and Seneca Sts. Estimated cost $2,000,000.

Ind., Indianapolis — L. S. Ayres & Co., Meridian and Pearl Sts., awarded contract for an 8 story stores building, to E. C. Strathmann, 712 Meyer Kiser Bldg. Estimated cost $1,500,000. Steam heating system, etc., will be installed.

Md., Baltimore—C. Hoffberger Co., Gay and Oliver Sts., awarded contract for the construction of a cold storage plant and warehouse at 538 East Monument St. to M. A. Long Co., 10 West Chase St. Estimated cost $550,000.

Mass., Attleboro—City is receiving bids for the completion of waterworks system including pumping station, etc. Estimated cost $200,000. E. J. Valkenburgh, Smith Bldg., Framingham, is engineer.

Mass., Brockton—Brockton Ice & Coal Co., J. J. McCarthy, 426 Main St., awarded contract for an ice manufacturing plant on Lawrence St. to H. F. Johnson, 248 Belmont St. Estimated cost $75,000.

Mass., Brockton—Cudahy Packing Co., 37 Merchant St., Boston, awarded contract for the construction of a cold storage plant on North Montello St. here to George Howard & Sons, 142 Main St., Brockton. Estimated cost $75,000.

Mass., Swampscott—W. J. Snow, c/o Blackall, Clapp & Whittemore, 31 West St., Boston, Archts., is having preliminary sketches made for a 13 story hotel on Humphreys St. Estimated cost $700,000.

Mich., Detroit—Central Realty Co. and Adcraft Club, 2111 Woodward Ave., awarded contract for a 22 story club and office building on Bagley Ave. to Blair Construction Co., 3212 Book Tower. Estimated cost $2,000,000. Steam heating and ventilation systems, boilers, etc. will be installed.

Mich., Grand Rapids—Consumers Power Co., Pearl St., awarded contract for first unit of steam generating plant on Wealthy St. Estimated cost $300,000.

Mich., Royal Oak—Grant S. Oliver Co., 300 East Fourth St., is having plans prepared for a 10 story hotel including steam heating and ventilation systems, boilers, elevators, etc. on Second St. Estimated cost $750,000. Architect not announced.

Minn., Willmar—City, H. Gunderson, Clk, will receive bids until May 28 for addition to power plant. Estimated cost $90,000. Pillsbury Engineering Co., 2344 Nicollet Ave., Minneapolis, is engineer.

Mo., St. Louis—Continental Life Insurance Co., E. Mays, Pres., 10th and Olive Sts., is having preliminary plans prepared for a 12 story bank and office building including steam heating system, etc. at Olive St. and Grand Blvd. Estimated cost $1,500,000.

Mo., St. Louis—Local Syndicate, c/o W. R. Orthwein, Boatmen's Bank Bldg., is having preliminary plans prepared for a 16 story hotel including steam heating system, etc. at 12th and Locust Blvds. Estimated cost $1,250,000. Manske & Bartling, 410 North Euclid Ave., are architects.

Mo., St. Louis—Syndicate, c/o H. R. Weisels Inc., 730 Chestnut St., is having preliminary plans prepared for a 12 story office building including steam heating system, etc. at Olive St. between 12th and 13th Sts. Estimated cost $1,500,000. P. J. Bradshaw, 718 Locust St., is architect.

N. J., Jersey City—Public Service Electric & Gas Co., 80 Park Pl., Newark, is having plans prepared for addition to transformer sub-station on Morgan St. Estimated cost $55,000. Public Service Production Co., 80 Park Pl., Newark, is engineer.

N. J., Linden—Grasselli Dyestuff Corp., Grasselli, is receiving bids for the construction of a switch house and transformer station here. Estimated cost $40,000. Private plans.

N. J., Newark—Majestic Holding Co., c/o W. E. Lehman, 972 Broad St., Archt., is having sketches made for a 15 story hotel including steam heating system, etc. at Broad and Hill Sts. Estimated cost $2,000,000.

N. J., Paterson — Mountain Ice Co., 51 Newark St., Hoboken, is having plans prepared for the construction of an ice plant

at 211-219 Lafayette St., here. Estimated cost $50,000. Private plans.

N. J., Paterson—Owner, c/o D. J. Scrocco, 60 Park Pl., Newark, archt., is having plans prepared for a 12 story office and stores building including steam heating and ventilation systems, boilers, elevators, etc. at Market St. and Railroad Ave. Estimated cost $850,000.

N. J., West Englewood—J. Ayres, c/o J. B. Peterkin, 285 Madison Ave., New York, N. Y., Archt., will build an apartment building, including steam heating system, etc. Estimated cost $1,000,000. Work will be done by separate contracts.

N. Y., Brooklyn—A. K. T. Holding Corp., H. Aaron, Pres., 26 Court St., had plans prepared for the construction of four apartment buildings at Rockaway Parkway and Winthrop St. Estimated total cost $1,000,000. C. Brass, 361 Stone Ave., is architect.

N. Y., Mamaroneck — Bd. of Trustees, Westchester Joint Waterworks No. 1, 9 Elm St., awarded contract for a new filtration plant, also remodeling of pumping station, to Roberts Filter Mfg. Co., Darby, Pa., and A. Di Marco, Woodside Ave., White Plains, N. Y.

N. Y., New York — Corporation, c/o R. Candala, 578 Madison Ave., Archt., awarded contract for a 17 story apartment building at Park Ave. and 70th St., to Starrett Bros., 101 Park Ave. Estimated cost $6,000,000.

N. Y., New York—E. & G. Development Corp., M. Ginsberg, Pres., 247 Park Ave., is having preliminary plans prepared for the construction of an apartment building at Madison Ave. and 76th St. Estimated cost $500,000. Architect not selected.

N. Y., New York—Electrical Testing Laboratories, 10-16 East End Ave., will soon receive bids for the construction of a 9 story office building. Estimated cost $1,600,000. T. E. Murray, 55 Duane St., is engineer.

N. Y., New York—Film Center Inc., A. Adelson, Pres., 65 West 39th St., awarded contract for a 13 story office and loft building at 622 9th Ave., to R. H. Howes Construction Co., 103 Park Ave. Estimated cost $1,500,000.

N. Y., New York—New York Edison Co., Irving Pl., awarded contract for the construction of a frequency changer building at 419 East 40th St. to Kennwell Contracting Co., 45 East 17th St. Estimated cost $450,000.

N. Y., New York—Joseph Polstein & Sons, 247 Park Ave., is having plans prepared for an 11 story apartment building at 836 Lexington Ave. Estimated cost $1,500,000 Pelham & Noble, 570 7th Ave., are architects.

N. Y., New York—One Hundred Eleven John St. Corp., L. W. Flaundlacher, V. Pres., 330 5th Ave., had plans prepared for a 26 story office and stores building at 103 John St. Estimated cost $3,500,000. Buchman & Kahn, 2 Park Ave., are architects.

O., Cincinnati—Cincinnati & Suburban Bell Telephone Co., Fourth St., plans the construction of a 15 story telephone building at 7th and Elm Sts. Estimated cost $2,000,000. H. Hake, 2400 Gilbert Ave., is architect.

O., East Cleveland (Cleveland P. O.)—Huron Road Hospital, S. A. Runnels, Supt., 8811 Euclid Ave., Cleveland, plans the construction of a hospital and nurses' home here. Estimated cost $750,000. A. M. Allen & Co., 7016 Euclid Ave., Cleveland, are architects.

O., Lakewood (Cleveland P. O.)—Lake Shore Hotel Co., c/o C. R. Cummins, Pres., Penton Bldg., awarded contract for a 10 story hotel at Edgewater Dr. and Cove Ave. to John Gill & Sons, Bulkley Bldg. Estimated cost $3,000,000.

Okla., Cheyenne—City will soon award contract for the construction of a complete new waterworks system including deep well pump and motor, etc.

Okla., Guthrie—New State Ice Co., 2 West 3rd St., Oklahoma City, is having preliminary plans prepared for the construction of a 30 ton raw water ice plant here. Estimated cost $60,000. Private plans.

Ore., Eugene—Eugene Water Board, C. A. McClain, Supt., will receive bids until June 5 for the construction of Leaburg hydro-electric development including diversion dam, power house, penstocks, etc. Stevens & Koon, Spalding Bldg., Portland, are consulting engineers.

Pa., Meadville—Erie R.R., 71 West 23rd St., New York, plans the construction of an ash handling plant, here. Estimated cost $90,000. R. S. Parsons is chief engineer.

Pa., Philadelphia — Grillon-Rittenhouse Sq. Corp., c/o Horace Trumbauer, Land Title Bldg., Archt., plans the construction of a 26 story hotel at 19th and Locust Sts. Estimated cost $2,000,000.

Pa., Philadelphia — Pennsylvania R.R., Broad St. Station, awarded contract for the construction of a cold storage and refrigerting plant with 1 story unit for power service, etc., at Oregon and Delaware Aves., to United Engineers & Constructors Inc., 125 East 46th St., New York, N. Y. Estimated cost $1,000,000.

Tenn., Dyersburg—City voted $120,000 bonds for extensions and improvements to municipal water and light plant.

Tex., Littlefield—M. L. Waller, 905 South Western Life Bldg., Dallas, Archt., is having plans prepared for a group of college buildings including power plant, etc. here for Littlefield College, c/o R. O. Connor, Bus. Mgr. Estimated cost $500,000.

Tex., Marble Falls—City plans an election to vote $50,000 bonds for improvements to waterworks and distribution systems including pumping plant, etc.

Va., Rural Retreat—Pet Milk Co., J. A. Latzer, Pres., Arcade Bldg., St. Louis, Mo., plans the construction of a refrigeration plant here. Estimated cost $50,000.

Wash., Aberdeen — Grays Harbor Railway & Light Co., W. W. Briggs, V. Pres. and Gen. Mgr., has work under way on the construction of a new 10,000 hp. unit to central generating plant at Electric Park. Estimated cost $1,500,000. R. V. Rosenbaum and O. Brockman, engineers of Sanderson & Porter organization, in charge.

Wis., Milwaukee—Owner, c/o F. P. Jones & Co., 82 East Wisconsin Ave., is having sketches made for a 13 story at East Wisconsin and East Water Sts. Eschweiler & Eschwieler, 210 Mason St., are architects.

N. S., Halifax—Cowie & Drury Interests of Montreal, awarded contract for excavation, etc., for a cold storage plant including warehouses, power house, ice-making plant, etc., here. Estimated cost $1,600,000.

Ont., London—London Loan Co., J. H. Hambly, Mgr., 220 Dundas St., plans the construction of a new office building including steam heating system, etc. Estimated cost $750,000. Architect not selected.

Ont., Windsor—International Terminals Ltd, Bartlett Bldg., is having plans prepared for a 6 story warehouse including steam heating and refrigeration systems, etc. Estimated cost $1,000,000. A. W. Connor, Metropolitan Bldg., Toronto, is architect.

Equipment Wanted

Boilers, etc.—Dept. of Mental Hygiene, Albany, N. Y., will receive bids until May 29 for heating boilers, etc., for State Infantry Armory, Ogdensburg, N. Y.

Power House and Filtration Plant Equipment—Water Commission, Niagara Falls, Ont., wants prices and catalogs on complete equipment for proposed power house and filtration plant, to cost $400,000.

Power Plant Equipment—City, of Willmar, Minn., H. Gunderson, Clk., will receive bids until May 28 for complete equipment for proposed addition to power plant. Estimated cost $90,000.

Pump—F. Scholz, 590 Tremont St., Boston, Mass., plans to purchase an electrically driven well pump.

Pump, etc.—Town of Wiggins, Miss., J. P. Clendenin, Mayor, will receive bids until May 29 for a motor driven centrifugal pump, etc., for proposed waterworks system.

Pump, Motor, Etc.—Village of Kenyon, Minn., will receive bids until May 28 for a 500 g.p.m. deep well turbine centrifugal pump, electric motor, etc. Estimated cost $16,000.

Pump and Motor—B. B. Moore, Clk., El Monte, Calif., will receive bids until May 28 for furnishing and installing a 1,500 g.p.m. deep well turbine pump and 100 hp. motor for proposed waterworks improvements.

Pumping Equipment—City of Stamford, Tex., plans to purchase pumping equipment, etc. for proposed improvements to waterworks and distribution systems. Estimated cost $30,000.

Pumps—U. S. Property & Disbursing Office of Wisconsin, Camp Douglas, Wis., will receive bids until June 2 for electrically driven pumps, etc. for proposed waterworks improvements.

Pumps and Motors, Etc.—City of Aurora, Kan., A. N. Landue, Clk, will receive bids until May 25 for two pumps and motors, etc. for proposed waterworks improvements.

Industrial Projects

Calif., Redwood City—CELITE PRODUCTS FACTORY—Celite Products Co., Lompoc, has acquired the National Magnesia Co.'s plant here and plans to expend $200,000 for plant additions and equipment.

Conn., West Haven (New Haven P. O.) — FACTORY — Western Electric Co., 80 John St., New Haven, will soon award contract for a 2 story factory here. Estimated cost $50,000. Private plans.

Ga., Rome—RAYON MILL—American Chatillon Corp., 393 7th Ave., New York, N. Y., is having plans prepared for the construction of a rayon mill here. Estimated cost $4,000,000. Lockwood, Greene & Co., 1 Pershing Sq., New York, N. Y., are engineers.

Kansas—PUMICITE PLANT—Pumicite Co., Ambassador Bldg., St. Louis, Mo., will build plants at Stanley, Wilmore, Fowler and Meade, Kan. Estimated cost $30,000 each. L. Heidenrich Engineering Co., 620 Central Exchange Bldg., Kansas City, Mo., is engineer. Work will be done by day labor.

Md., Baltimore — SOAP FACTORY — Proctor & Gamble Co., Gwynne Bldg., Cincinnati, O., is having plans prepared for the construction of a soap factory here. Estimated cost $3,500,000. H. Manley, 550 East 53rd St., New York, N. Y., is architect.

Mass., Cambridge (Boston P. O.)—PYROFAX PLANT—Union Carbide & Carbor Co., 30 East 42nd St., New York, N. Y., will soon award contract for a plant here. Estimated cost $40,000. Private plans.

Mich., Detroit — AUTO ASSEMBLY PLANT—Chrysler Motor Car Co., East Jefferson Ave., is having plans prepared for a 1 and 2 story, 300 x 1000 ft. plant. Smith, Hinchman & Grylls, 800 Marquette Bldg., are engineers.

Mich., Detroit — CREAMERY — Wayne Creamery Co., 1329 Watertown Ave., is having plans prepared for a 2 story creamery on Livernois Ave. Estimated cost $50,000. F. Bergsma, 9698 Grand River Ave., is architect.

Mo., St. Louis—COMMISSION MARKET—Market Development Co., c/o C. E. Richardson, International Life Bldg., is having preliminary plans prepared for a commission market at Chouteau St. between Rankin and Compton Aves. Estimated cost $2,000,000.

N. J., Hillside—FLOUR MILL—Washburn-Crosby Co., 117 Liberty St., New York, N. Y., plans the construction of a 2 story mill here. Estimated cost $50,000. Architect not selected.

N. J., Newark — WATERPROOFING FACTORY—Anti-Hydro Waterproofing Co., 265 Badger Ave., awarded contract for the construction of a 3 story, 60 x 100 ft. factory at 279-285 Badger Ave. to Shore Construction Co., 94 Christi St. Estimated cost $60,000.

N. C., New Bern—CEMENT PLANT—Carolina Cement Co., R. C. Clark, Secy. and Treas., Raleigh, had plans prepared for a cement plant, 4,200 bbl. daily capacity, including power house, 160 x 160 ft., kiln building, 110 x 500 ft., grinding building, 100 x 460 ft., machine shop, 50 x 160 ft., etc. Estimated cost $3,000,000. S. E. Flexner, New Bern, is consulting engineer.

O., Elyria—AUTO BEARING FACTORY—Williams Alloy Products Co., plans the construction of a 1 story factory. Estimated cost $40,000.

Tex., Houston—SALT PLANT—United Salt Corp., c/o J. M. Howe, Pres., First National Bank Bldg., plans the construction of a salt evaporating plant, 250 ton daily capacity. Estimated cost $500,000. Architect and engineer not selected.

Tex., San Antonio—CANDY FACTORY—Brown Candy & Cracker Co., 810 South Medina St., plans the construction of a factory at El Paso and Medina Sts. Estimated cost $350,000. Private plans.

Va., Lowmoor — GAS PLANT — Intercontinent Gas Co., M. W. Ditto, 11 Broadway, New York, N. Y., is having preliminary plans prepared for the construction of a plant, etc., to supply gas to Covington and Clifton Forge, Va. Estimated cost $10,000,000.

Ont., Windsor — SHIP CONTAINER FACTORY—London Shipping Container Co., 745 York St., London, awarded contract for a 1 story, 125 x 150 ft. factory on Hall St. here, to Ernest Clark Ltd., Windsor. Estimated cost $50,000.